the OIL AND GAS JOURNAL

PUBLISHED WEEKLY APRIL 3, 1961

47 PROCESSES FOR '61 REFINING

Simplified flow diagrams . . . Brief descriptions and yield data of all the processes needed to make today's refinery competitive in price and octanes.

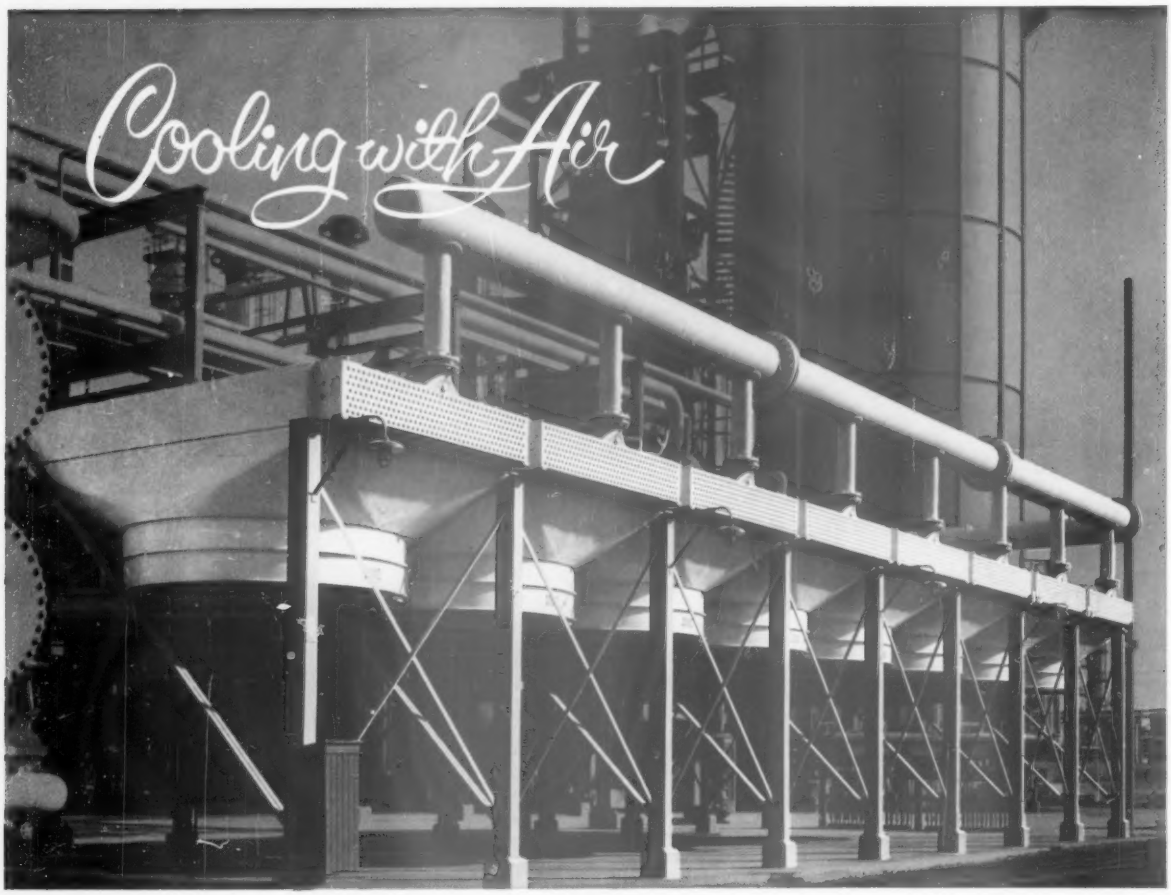
p.115

Refiners' capacity still growing faster than runs ▸ 93

Turnkey drilling spreads despite contractor opposition ▸ 98

Sahara oil: Major issue in Algerian peace talks ▸ 111

Journal's annual survey of U. S. and Canadian refineries (p. 164) and of refinery construction (p. 189)



IN THE BAYWAY REFINERY . . .

of the Esso Standard Division of Humble Oil and Refining Company.

The above pictured installation of HUDSON Solo-aire units obviated costly addition to the existent and comparatively high-maintenance-cost water system.

Over-all economic comparisons of HUDSON Solo-aire cooling versus water cooling almost invariably result in selection of Solo-aire units for much or all process cooling.

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Operating results of thousands of HUDSON Solo-aire units installed in oil, gas and chemical plants throughout the free world have established HUDSON leadership in the field of direct cooling with air.

ONLY HUDSON designs and manufactures ALL THREE categories of cooling equipment . . . for cooling solely with air (Solo-aire); for cooling primarily with air but with minimum water to obtain low effluent process stream temperatures (Combin-aire); and water cooling towers. Take advantage of HUDSON'S objective assistance in selecting the integrated cooling system which best balances capital investment and operating cost for the specific process, climatic, and water conditions.

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Annual Survey of Capacities of U. S. Refineries 164

By R. B. Bizal and K. W. Brooks

Exclusive 1961 survey of the nation's 298 refineries shows calendar-day capacity has inched up to 9,933,000 bbl. Hydrogen treating shows a sizable gain.

Annual Survey of Capacities of Canadian Refineries 185

The new table of Canada's 45 refineries shows calendar-day capacity fast approaching the 1,000,000-bbl. mark.

Refiners Tackle 50 Construction Projects 189

Refinery construction in the U. S. and Canada will add about 120,000 bbl. daily to U. S. crude capacity. Most of the new units are for downstream capacity or replacement.

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the OIL AND GAS JOURNAL Newsletter

Tulsa, Okla.
April 3, 1961

Relief from excess refining capacity won't come for years:

An increase in capacity of 144,000 bbl. per calendar day during 1960 is revealed in the Journal's refining survey (p. 93)*. This outstripped the gain in crude runs by almost 2 to 1.

Result: The capacity cushion is greater this year by 0.6%. Refiners in 1960 operated at 81.8% of capacity while the rate for the year before was 82.4%.

If capacity continues to increase at the present rate of 1.6% per year and crude runs increase only 2% per year, refiners by 1970 still will be operating at only 86% of capacity.

Given a 3% per year increase in runs—a very optimistic outlook for demand—refiners will be operating at only 90% of capacity in 1967.

Hydrocracking continues to interest many refiners.

Look for this new technique for converting middle distillates to high-quality gasoline to spread first in sweet-crude areas.

Construction costs are lower and operating problems fewer where sulfur corrosion protection is not needed. Low cost hydrogen from cat reformers is available in greater quantity when not required for desulfurizing petroleum fractions.

The popularity of other processes: Thermal cracking is still off while cat cracking gains slightly. Hydrogen treating spurted upward. Cat reforming, alkylation, and isomerization held steady due to a lessening of pressure on octanes.

▼ ▼ ▼

Contract scouting may spread to the Gulf Coast areas of Texas and Louisiana. The possibilities are currently being studied by committees of company exploration people in the regions.

At least three contract scouting services, being used in other areas, have evidenced an interest in bidding for the work if the operators decide to switch.

Domestic wildcats worth noting:

Blair-Murfin 1 Zimmer adds Frontier County to Nebraska's oil-producing areas. It got good showings of oil and gas in tests of the basal sand at 4,143-4,234 ft. Location is near St. Ann, 7 miles

---

*Refers to article in this issue giving more details. When no page is given, the item is a Newsletter exclusive.

north of production in Red Willow County.

Mobil 1 Horton in Custer County, Okla., is that county's first oil producer, has gas in the deepest Mississippian pay zone anywhere, and the Mississippian section is 3,600-ft. thick. Oil flowed at rate of 188 bbl. daily on choke from Osego at 9,722-78 ft. and gas at rate of 1,018 M.c.f. daily in Mermac at 13,192-360 ft.

Walhalla 1 York in Haynes Township, Alcona County, is Michigan's farthest northeast wildcat. It showed gas and oil in Detroit River beds from 1,758-61 and 2,057-114 ft. If commercial, it will spark a new interest in northern Michigan.

▼ ▼ ▼

Seismic work will be pushed this summer by Colorado Oil & Gas to evaluate a large part of its Alaskan acreage between Yakutat and Dry Bay. Several stratigraphic tests ranging from depths of 4,000 to 5,000 ft. may be drilled.

Project to develop Gubik gas structure in northern Alaska and to build a pipeline to deliver the gas into Fairbanks is still under consideration.

Key to future of project: Effect on future gas demand caused by recent changes in military operations in Fairbanks. Assurance of permanent military demand is essential.

Latest report on Standard-Richfield's Swanson River-Soldotna Creek unit in Alaska: 21 wells completed, 20 producing at total rate of 10,000 bl. daily. Six rigs are operating. Exploratory drilling now has started in the group's Falls Creek Unit in Alaska.

▼ ▼ ▼

The Washington beat:

It's a good bet that Interior will act to end the "Brownsville Plan" of gaining exemption for certain oil imports.

Currently tankers deliver oil at Brownsville in bond. It is taken into Mexico and then trucked back into the U. S., thereby becoming a control-exempt "overland" shipment.

Interior officials say they are giving this practice a hard look.

A tip: Oil firms might benefit by calling Interior Secretary Stewart Udall's attention to past performance of the Oil Import Appeals Board which has turned down virtually all appeals.

A new appeals board is now being set up, and Udall might be receptive to suggestions that the board be given more leeway to exercise judgment.

A decision is expected soon whether the military will try to use the barter method in its oil purchases abroad.

The purpose would be to send surplus commodities instead of hard cash as payment. Brokers would handle the commodities so the selling oil company would get money, not grain.

Interior is planning two hearings on crude oil import controls—one on the West Coast for District 5 and the other in Washington.

The hearings probably will be held in early May and will provide the administration a general look at the system. No major revisions in the program are currently in the hopper.

▼ ▼ ▼

Market trends as seen by API Marketing Chief Vernon A. Bellman of Mobil:

Car population in this decade will increase 3.3% per year but increase in gasoline demand will be only 2.4% annually. The growth rate for gasoline thus will be only half that of the 1950's, and you can lay much of the blame to compact cars.

Natural gas will surpass fuel oil in the home-heating market in this decade. Distillates now hold 41% of market and gas 36%. Fuel-oil demand will increase 1.3% per year for a total 14% jump by end of 1970. Gas demand will rise 4.5% per year for a 53% increase over the decade. The result: Gas will hold 45% of the market in 1970 and heating oil will have only 34%.

Tests by Sun Oil show that motor oil can be packaged successfully in aluminum foil cans. Performance is comparable to containers now in use. Advantages: A 15 to 20% initial cost reduction and savings in weight of about 50%.

▼ ▼ ▼

Communist China is now producing almost 100 different kinds of petroleum products.

The nation also is able to build 90% of its own petroleum prospecting and refining equipment.

These claims are made in a survey of China's progress in oil in the last 10 years which has been translated and published by the U. S. Department of Commerce.

Other oil trends abroad:

Colombian operators face a new oil law that sharply increases cost of doing future business. It ends 50-50 profit split, jacks up surface rentals and royalties on government land and the exploitation tax on production from private lands (p. 112).

Export-Import bank has spelled out new policy enabling U. S. makers of oil equipment to get government-credit backing on certain foreign sales (p. 102).

Future of Sahara's oil is knottiest problem facing French and Algerians when they sit down this week at Lake Geneva in talks trying to end bloody guerrilla war (p. 111).

Foreign operators started off the new year by breaking all previous production records for January—a 11.4-million barrel average.

Domestic production also is currently on the heavy side, averaging 7,382,700 bbl. daily for the latest week, a gain of 16,000 bbl. daily. This is the fifth week in a row for production to gain.

Market Memo

April 3, 1961

Reaction to Gulf's price boost in West Texas-New Mexico is slow.

Standard of Texas met the advance.

Other big buyers only say they have the matter under close study.

Gulf raised its sour-crude postings for the area 6 cents per barrel to a $3.01 top for 40°-gravity oil and substituted a 2-cent downward differential for the old 3-cent one.

The raise thus averages out at about 12 cents per barrel.

Gulf takes about 132,000 bbl. daily in the area. Texas Standard takes another 2,000 bbl. About 750,000 bbl. daily is available.

Back of the price push: West Texas sour has been in heavy demand for months at coastal refineries. It has high profitability compared with more expensive East Texas and Gulf Coast crudes.

Noting this spread, buyers for some time have observed that East Texas and Gulf Coast crudes were due a cut or West Texas due a raise. Cuts would have upset the price structure all over. Gulf's increase may restore balance with less repercussions.

A good bet: The Gulf hike won't lead to a general price boost.

A good trend: Refinery runs have dropped for the third straight week, going to 7,897,000 bbl. daily. It's the first time this year they've dropped below 8 million barrels.

The result was a 4,216,000-bbl. reduction in stocks of the four major products. Middle distillate stocks fell 4.5 million barrels while gasoline increased 1.1 million.

The trend should continue into May to restore product balance since April usually is a low demand month.

Product markets leave much to to be desired.

Chicago postings dropped one-half cent on gasoline, one-fourth on burning oils. This leaves No. 1 at 10 cents, No. 2 at 9.5 cents, 92-octane gasoline at 11.5 cents, 98-octane at 13.375 cents. Cuts stemmed from practice of some wholesalers giving spot unbranded customers price relief.

The low Chicago price is keeping Mid-Continent and River sellers out of the Chicago market. Sellers in both areas aren't cutting yet to match the lower prices. Mid-Continent prices seem firm at 11.75-12 cents for spot 91-octane gasoline and 10 and 9 cents for No. 1 and No. 2. River sellers are trying to hold at the Gulf lows.

Gulf suppliers face discounts of one-fourth cent on 92-octane and three-eighths on 100-octane. Spots range from 10.75-11.25 cents for the regular and 11.75 to 12.25 for premium. No. 6 fuel, long a bulwark of the market, slipped 10 cents to $2.20.

East Coast got its spring break in distillate prices—0.4 to 0.5 cents at wholesale levels and 0.2 to 0.4 cents on tankwagon prices. Gasoline prices were holding except in Florida.

Dial "S" for service

It can get pretty lonely around 2 a.m. The cleaners and charwomen have gone home. There's only one light on in the whole building.

Suddenly, the phone rings. Somewhere a refinery man needs expert technical assistance, somewhere there is a catalyst emergency that couldn't wait to happen. A pleasant voice in the night asks, "I have a collect call from Texas for SAratoga 7-3912, sir. Will you accept charges?"

Sure you will.

Why should Davison keep a telephone open, why should Davison keep a Technical Service Engineer on call day and night, seven days a week . . . just to answer service questions or provide catalyst in a hurry?

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If you have an emergency catalyst problem or want facts about catalysts . . . dial "S" the 24-hour service phone number (SAratoga 7-3912, Baltimore, Maryland.)

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PLUS VALUES OF THESE NEW STARTERS

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- A-B "quality" throughout

a complete new line of Bulletin 709 motor starters

Thirty years of experience have gone into the design of this new Allen-Bradley line of motor starters. While retaining the simple solenoid principle—with only ONE moving part—these Bulletin 709 starters are *completely new in every way.*

They are amazingly smaller—especially in the higher ratings. Yet test after test proved they will outlast any starter now on the market *by many times!*

The new, patented, high-efficiency magnet—remarkably powerful for its size and weight—is cushioned to reduce shock and wear. The new molded coils are protected against damage and harmful atmospheres. The new, precision hot molded arc hoods confine the arc and increase interrupting capacity.

New weld-resistant, cadmium oxide silver contacts close and seat firmly—without wear-causing motion. The new overload relays are not only *trip-free* but also *tamperproof*—but the "heaters" remain unchanged. The smart, new cabinets—by Brooks Stevens—are an asset on any type of installation. Better write for full details on this revolutionary new "family" of Bulletin 709 *quality* motor starters.

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Quality Motor Control

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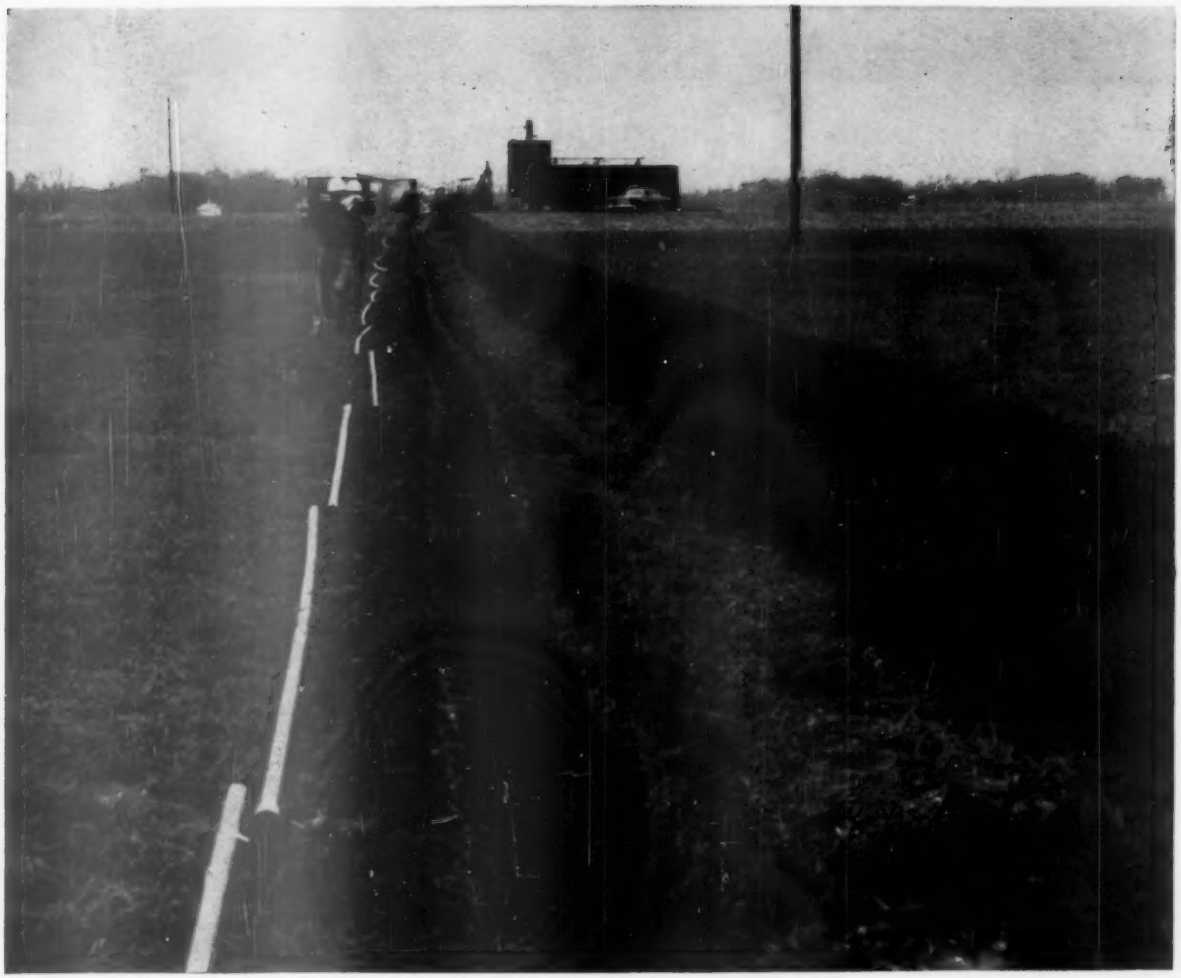

Pipe the easy way to lay salt water disposal lines

Koroseal PVC pipe cuts installation time in half, won't corrode, can't rust or rot, doesn't clog up

INSTALLING a Koroseal pipeline is remarkably easy. It's so light two men can carry 10 lengths of it without strain. It can be laid in half the time it takes to lay steel pipe. And Koroseal can be joined with labor-saving solvent-cementing that will not work with other pipe.

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Koroseal's mirror-smooth interior finish virtually eliminates the buildup of salt and paraffin that clogs other systems. Because of the smooth interior, a 1½" Koroseal pipeline handles the same quantity as a 2" steel pipe. At the oil field pictured above, the 3390-foot Koroseal disposal line will handle 4200 gallons of salt water a day.

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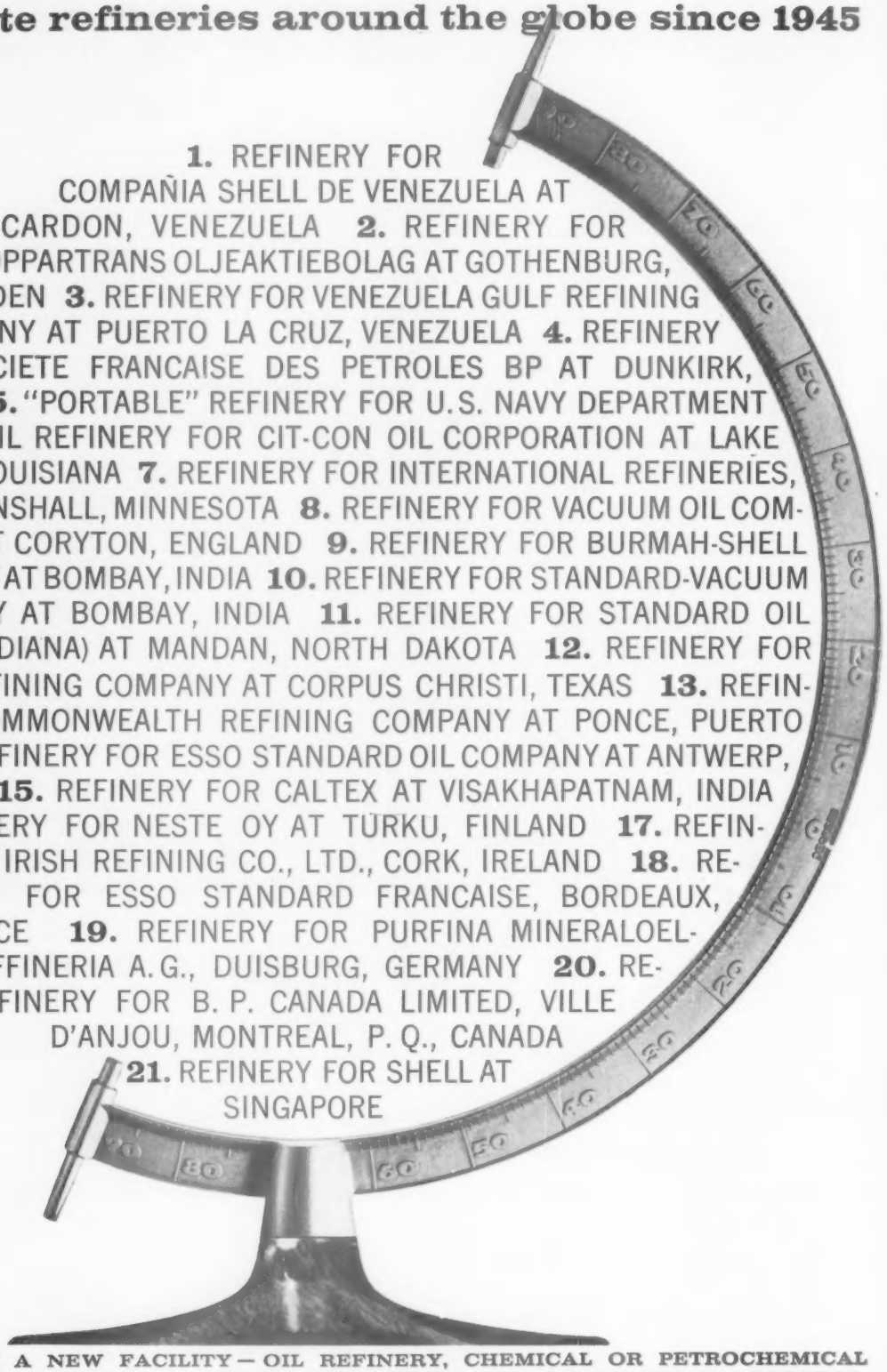

1. REFINERY FOR COMPAÑIA SHELL DE VENEZUELA AT CARDON, VENEZUELA **2.** REFINERY FOR KOPPARTRANS OLJEAKTIEBOLAG AT GOTHENBURG, SWEDEN **3.** REFINERY FOR VENEZUELA GULF REFINING COMPANY AT PUERTO LA CRUZ, VENEZUELA **4.** REFINERY FOR SOCIETE FRANCAISE DES PETROLES BP AT DUNKIRK, FRANCE **5.** "PORTABLE" REFINERY FOR U.S. NAVY DEPARTMENT **6.** LUBE OIL REFINERY FOR CIT-CON OIL CORPORATION AT LAKE CHARLES, LOUISIANA **7.** REFINERY FOR INTERNATIONAL REFINERIES, INC. AT WRENSHALL, MINNESOTA **8.** REFINERY FOR VACUUM OIL COMPANY LTD. AT CORYTON, ENGLAND **9.** REFINERY FOR BURMAH-SHELL OIL COMPANY AT BOMBAY, INDIA **10.** REFINERY FOR STANDARD-VACUUM OIL COMPANY AT BOMBAY, INDIA **11.** REFINERY FOR STANDARD OIL COMPANY (INDIANA) AT MANDAN, NORTH DAKOTA **12.** REFINERY FOR SUNTIDE REFINING COMPANY AT CORPUS CHRISTI, TEXAS **13.** REFINERY FOR COMMONWEALTH REFINING COMPANY AT PONCE, PUERTO RICO **14.** REFINERY FOR ESSO STANDARD OIL COMPANY AT ANTWERP, BELGIUM **15.** REFINERY FOR CALTEX AT VISAKHAPATNAM, INDIA **16.** REFINERY FOR NESTE OY AT TÜRKU, FINLAND **17.** REFINERY FOR IRISH REFINING CO., LTD., CORK, IRELAND **18.** REFINERY FOR ESSO STANDARD FRANCAISE, BORDEAUX, FRANCE **19.** REFINERY FOR PURFINA MINERALOEL-RAFFINERIA A.G., DUISBURG, GERMANY **20.** REFINERY FOR B. P. CANADA LIMITED, VILLE D'ANJOU, MONTREAL, P. Q., CANADA **21.** REFINERY FOR SHELL AT SINGAPORE

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...eliminates underfilm corrosion
in finished product tanks

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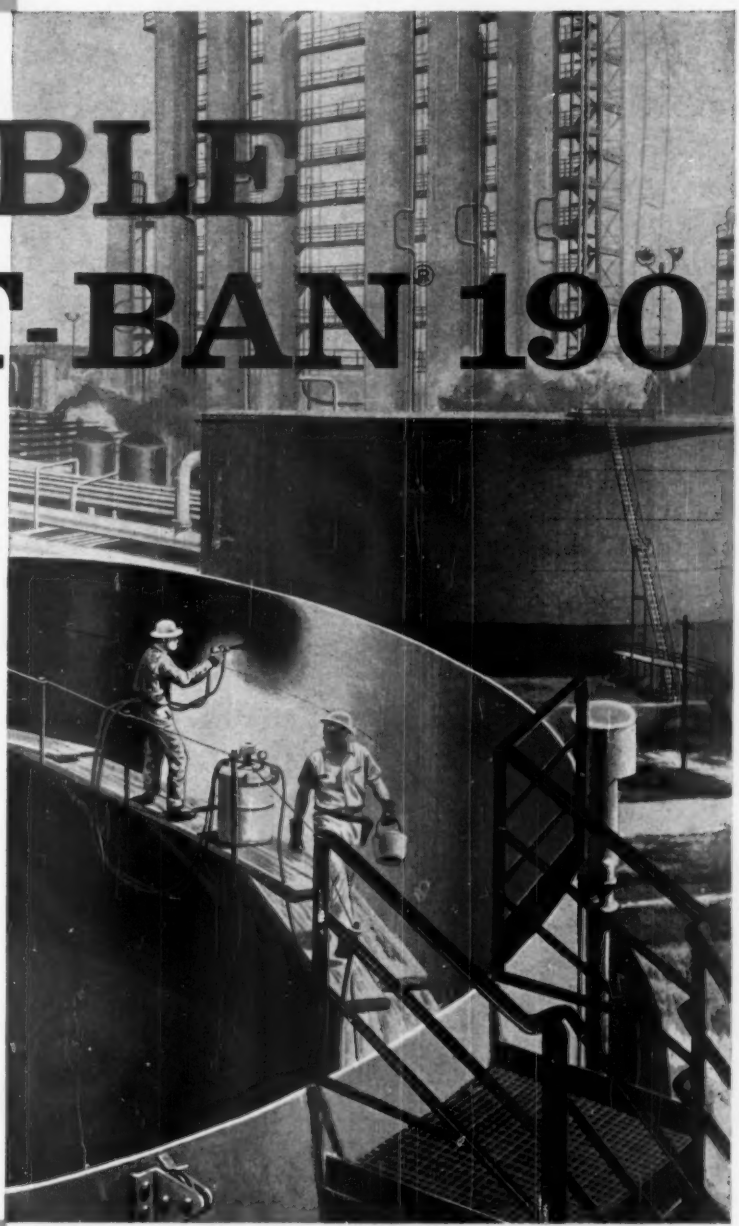

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The hard, abrasion-resistant coating of 100% inorganic zinc silicate is virtually impervious to the scraping action of floating roofs. RUST-BAN 190 is nonflammable, does not contaminate even high-purity products.

When properly applied and cured (with its companion RUST-BAN 195) RUST-BAN 190 provides many years of protection at far lower annual cost than any other type of coating!

For complete information about RUST-BAN 190 and other Humble Protective Coatings, call your Humble salesman or contact Humble Oil & Refining Company, Houston, Texas.

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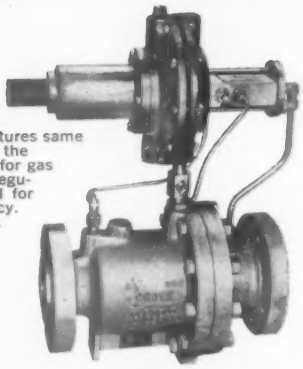
Model 888, self-operated, gas dome-loaded. Setting is fast, easy, without springs or pilots. Recommended for natural gas, air and liquids. Bulletin #888-D.

GAS PRESSURE REDUCING FLEXFLOS

Model 80-820 where extreme accuracy is critical. Sensitive, spring loaded model 820 Grove pilot is a diaphragm controlled, three-way throttling valve. Seven adjustable spring ranges from 2 psi to 1200 psi. Send for Bulletin #813-B.



Model 80-830 features same type of pilot as the 80-820, adapted for gas back pressure regulation. Designed for extreme accuracy. Bulletin #813-B.

Grove Sets Regulator Standards for Others to follow

Model 80-896A, designed for "pounds to ounces" pressure reduction. For inlet pressures to 100 psi and adjustable control ranges from 2 ounces to 20 psi. Bulletin 813-B.

Model 80-833, for low pressure services. 833 pilot is available with three adjustable spring ranges: 10-30 psi, 15-75 psi and 25-150 psi. Bulletin #813-B.

KEY TO OIL FINANCING

National Bank of Tulsa . . . The Oil Bank of America . . . continues to key its own progress to the healthy growth of the oil industry. Financing is the key to the oil industry's growth, and NBT has grown with the industry by continually expanding its services to finance oil operations for oil men across the nation. When you transact business in the New World of Banking at NBT, you deal with oil men like yourself . . . at the Oil Bank of America.

NATIONAL BANK OF TULSA

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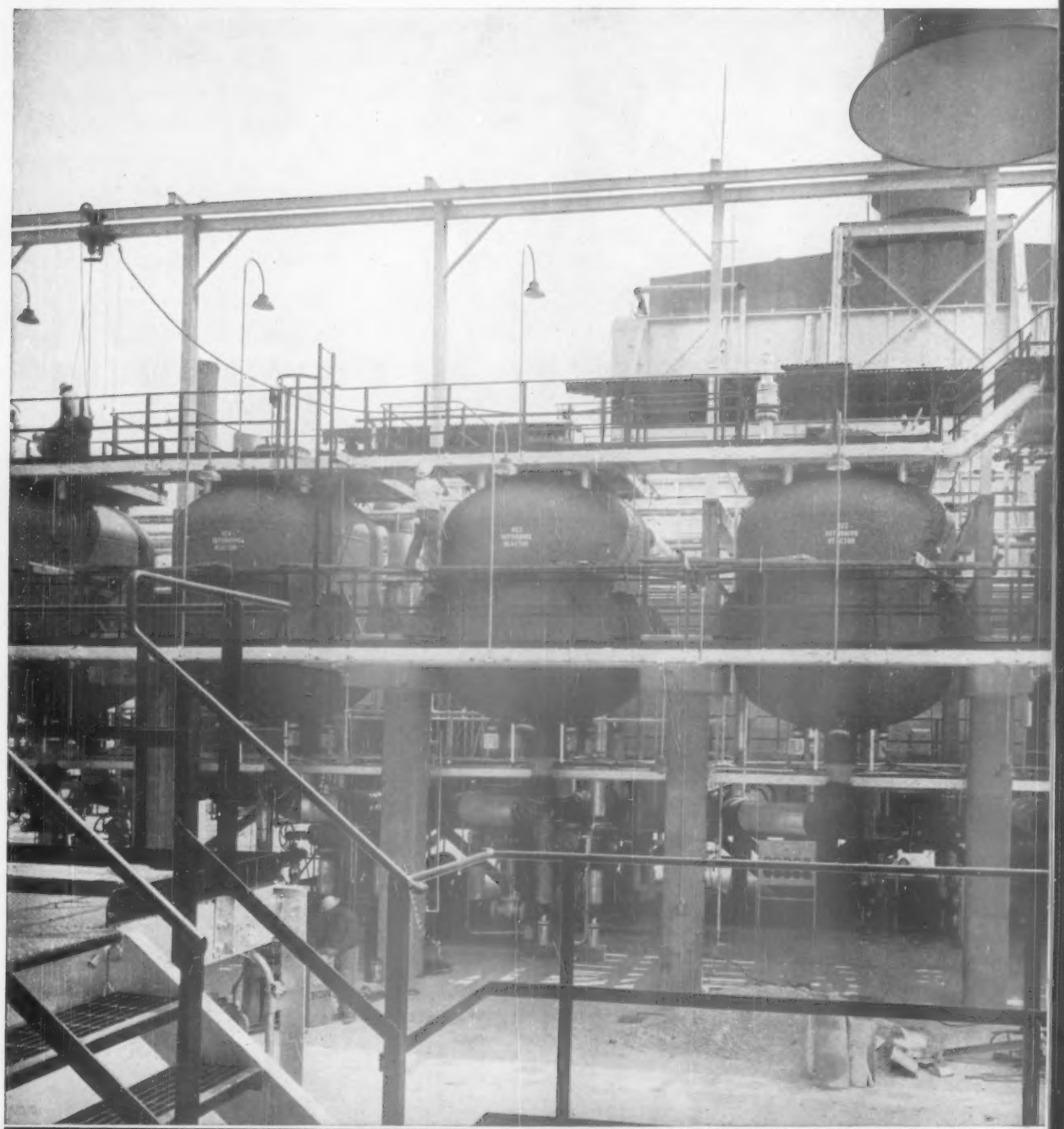

Investment in Cat Reforming

WORLD-WIDE RANGE OF INSTALLATIONS SHOWS FLEXIBILITY OF KELLOGG ENGINEERING-CONSTRUCTION SERVICES

To improve octane rating or to meet increased demands for petrochemicals, Kellogg is uniquely equipped to design or erect catalytic reformers to meet any specific need. Combined with Kellogg-designed hydrotreating facilities, cat reforming produces high octane gasoline of superior quality. The reformate is also a rich source of aromatics for petrochemical production.

Feedstocks reformed include light, heavy, and full-boiling virgin naphthas as well as thermally and catalytically cracked stocks which have been selectively pretreated. Products include aromatics such as benzene, toluene, and xylenes plus isobutane and hydrogen.

For further information on how Kellogg can optimize your investment in cat reforming, you are invited to send for an 8-page folder—"Regenerative Catalytic Reforming".

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Offices of other Kellogg companies are in Toronto, London, Paris, Rio de Janeiro, Caracas, Buenos Aires

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KELLOGG CAT REFORMING EXPERIENCE

Heath, Ohio	3,000 BPD
Houston, Texas	24,000 BPD
Bakersfield, California	4,000 BPD
Grand Prairie, Alberta	875 BPD
Antwerp, Belgium	2,500 BPD
Toledo, Ohio	12,000 BPD
Ponca City, Oklahoma	11,000 BPD
Lemont, Illinois	12,000 BPD
Vancouver, B.C.	4,000 BPD
Denver, Colorado	3,800 BPD
Montevideo, Uruguay	3,000 BPD
Concon, Chile	6,000 BPD
Kent, England	10,000 BPD
Dunkerque, France	10,000 BPD
Kwinana, Australia	10,000 BPD
Antwerp, Belgium	10,000 BPD
El Palito, Venezuela	6,500 BPD
Fremantle, W. Australia	6,000 BPD
Amarillo, Texas	5,000 BPD
Dinslaken, Germany	12,500 BPD
Izmit, Turkey	2,500 BPD*
Karachi, Pakistan	2,250 BPD*
Texas City, Texas	22,300 BPD
Wood River, Illinois	9,000 BPD
Baytown, Texas	20,000 BPD
Pointe aux Trembles, Quebec	4,500 BPD
Texas City, Texas	7,500 BPD
Ponca City, Oklahoma	3,850 BPD
Baytown, Texas	16,500 BPD
Oleum, California	8,000 BPD
Lockport, Illinois	7,500 BPD
Whiting, Indiana	9,250 BPD
Toledo, Ohio	5,500 BPD
Buenos Aires, Argentina	740 BPD
Destrehan, Louisiana	2,000 BPD
East Chicago, Indiana	12,780 BPD
Lake Charles, Louisiana	17,250 BPD
Whiting, Indiana	30,000 BPD
West Tulsa, Oklahoma	7,500 BPD
Regina, Saskatchewan	3,000 BPD
TOTAL	348,095 BPD

*Future

PULL A VACUUM AND SWAB THE WELL CLEAN

with GUIBERSON GW CUPS

Save time.. save money.. save *fluid*.. with GW cups.. with Casing Swabs — products of Guiberson's more than a third century's experience serving the oil industry.

GW cups assembled on famous Guiberson Casing Swab

If you want to *swab* — not just agitate — flexible GW cups on the Guiberson Casing Swab will pull every drop. They hug the casing wall — provide automatic seal and controlled pipe contact — pull a vacuum and clean the well!

Precision molded in Guiberson's own rubber plant from special abrasion resistant compound, GW cups take up their own wear. They are unexcelled in rough or mixed casing strings and for unloading shallow wells. Won't down-swab or hang on casing collars. Interchangeable on the famous Guiberson Casing Swab.

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A Nalco PRODUCT MANAGER Answers Questions About Refinery Desalting Practices and Economics

Apparently Efficient Desalting Operations May Be Hiding Big Operating Costs

Here are some questions about desalting that we are asked frequently in the field. Answers here are necessarily brief; but we believe Nalco has complete answers to virtually any conceivable desalting question . . . and we like to share them with refinery people . . .

Question: Why should refiners review desalting operations periodically?

Answer: Desalting can be a "sleeper" in many refineries, operating without the attention demanded by more complex processing—and sometimes doing an inefficient job that causes cumulative damage, or builds up operating costs unnecessarily. Periodic checks on desalting results and costs can be an important safeguard to overall operating efficiency.

Question: Is it reasonable to expect oil-free wash water effluent with an economical desalting operation?

Answer: Yes. Clean wash water effluent is one indication of effective desalting – but getting clean effluent does not need to indicate an expensive desalting operation.

Question: Can desalting chemicals be used with electrostatic desalting units?

Answer: Yes. They not only can be used, but with straight electrostatic desalting, results can be improved with the addition of small amounts of chemical. Nalco chemicals, for instance, have been used to treat charge stocks to electrostatic desalting equipment of all types for many years. Howe-Baker Engineers, Inc., a subsidiary of Nalco Chemical Company, designs and builds electrical desalting units; and their long, successful experience is shared by your Nalco Representative.

Question: How does Nalco treat the wide variety of crudes handled by some refineries?

Answer: Nalco's desalting chemicals are designed so that each is effective in treating a variety of crude types.

To select the best one for a refiner's present crudes (or those scheduled for future processing) screening tests are run at the refinery. Additional tests, if necessary, are performed at Nalco's desalting laboratory, using special equipment designed to reproduce actual refinery conditions.

The best chemical for the job is then chosen from Nalco's list of broad range formulas. It can be relied upon to do the best job at the lowest cost.

Question: Can Nalco chemicals increase throughput rates in existing desalting equipment?

Answer: Frequently. Whether existing equipment utilizes electrical desalting, chemical desalting, or a combination, improved chemical emulsion breaking can often speed up the desalting process . . . and, in effect, substantially increase the capacity of existing desalting equipment. In addition to boosting throughput, the use of Nalco Desalting chemicals has frequently enabled refiners to substantially reduce total chemical requirements.

Case histories in operations similar to your own may be of interest . . . and your Nalco Representative will gladly discuss them with you.

Nalco Product Manager for Petroleum Chemicals, R. C. Canapary, puts specialized knowledge to use in the field. Shown here (left) with one of the operating personnel of a large midwestern refinery, Canapary's expert assistance is an added assurance that Nalco desalting chemicals get results.

Question: Does Nalco have anything to offer where desalting is now satisfactory?

Answer: Yes: a careful check of desalting operations by a qualified expert. It may show that optimum desalting economy and efficiency is being maintained. Or it may reveal that greater economy or increased efficiency, or both, are possible. In either case, you will have an up-to-date, informed opinion of your desalting—at no cost to you.

Question: Just what does Nalco desalting service mean?

Answer: In terms of results, Nalco desalting service means continuously efficient desalting at lowest chemical costs. In setting up a desalting program, it means help from experts—in every phase of desalting technology. In terms of trouble-shooting, it means there is authoritative assistance available to you, now.

Where unusual desalting problems arise, Nalco service means the added skills and facilities of Nalco Laboratories, plus the concentrated attention of Nalco technical staff members whose principal jobs are solving special desalting problems and keeping Nalco Representatives ahead of the field in desalting know-how.

Regular testing continues where Nalco desalting chemicals are in use. The effort to better results and cut costs does not stop with the initial recommendations, nor is there the attitude of "letting well enough alone." You buy continuing *effort* and *responsibility* with every drum of Nalco chemical.

Why not put Nalco's expert desalting service to work for you today?

NALCO CHEMICAL COMPANY

6242 West 66th Place • Chicago 38, Illinois

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In Canada: Alchem Limited, Burlington, Ontario

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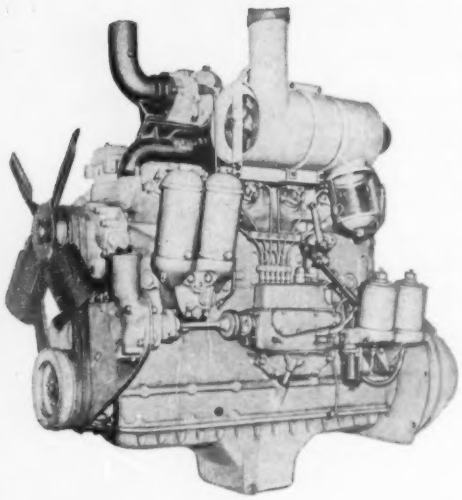
NEW International TD –

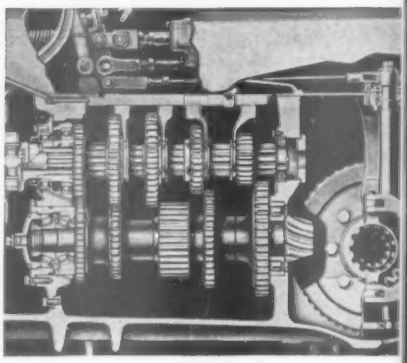
...built to "BEEF UP" your profit edge!

From air intake to new fixed drawbar —from day-to-day dependability through year-in, year-out durability—new strength, new performance protection, new work capacity are built into the new TD-20. Check and compare the advantages of International turbocharged Diesel power, teamed with beefed-to-match new transmission and final drive components—platformed on a far stronger-than-ever undercarriage—turned into new efficiency by International-built tracks, kept in life-prolonging alignment by exclusive International 3-point suspension. See your International Construction Equipment Distributor for a new TD-20 demonstration.



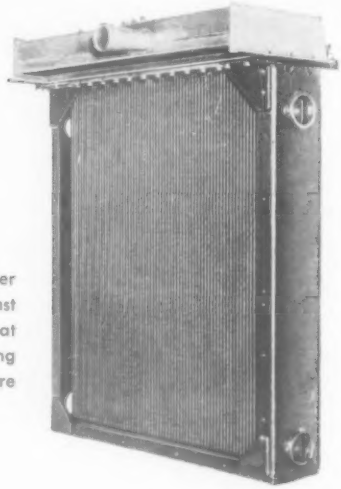
New Turbocharged Diesel Wallop

Modern turbocharging crams air into the new TD-20's smooth running 6-cylinder engine—to produce extra hp efficiently at all altitudes; and to give a 50% torque rise to lug larger overloads. Crankcase ribs are "beefed up;" cooling, air cleaning, and crankshaft capacity all are increased to team with turbocharging. Push-button TD-20 starting is by famous International gasoline-conversion system!



New transmission capacity ...New filtering system added

Heavier shafts, more rugged gears, and roller bearings of greater capacity are provided—to carry increased hp and add thousands of hours to working life of power train components. New transmission oil pump circulates and filters life-guarding lubricant. New "short-travel" levers add operating ease.



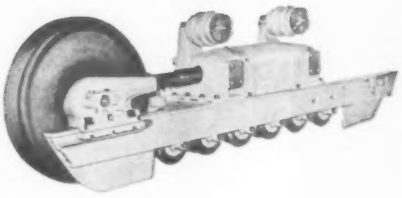
Larger radiator plus jet head increases cooling capacity

Coolant, under pressure from the new greater capacity radiator, is shot through jets against lower surface of TD-20 heads—to aid heat transfer and avoid build-up of heat-trapping deposits. Fan shroud and radiator guard are "heavied" for increased rigidity.

-20

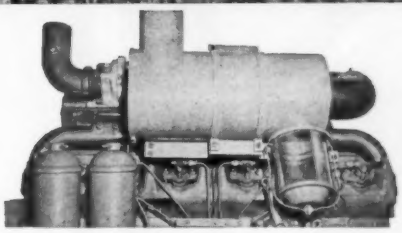
(201 SERIES)

New 140-hp International TD-20 crawler tractor. Develops 113 drawbar hp. Powered by 6-cylinder DT-691 Turbocharged Diesel engine. New capacity 6-speed, full-reverse transmission is controlled by new short-travel gear-shift and Shuttle-Bar levers.



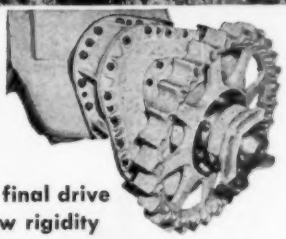
New Undercarriage Strength and Protection

New drum-type front idlers add strength... International also adds track chain guides to both sides of the TD-20's precision-welded double box-beam track frames! New track roller shields are of cast steel. New heavier strutless track links are self-cleaning and power-saving. The new hydraulic track adjuster, with built-in safety relief is "standard" on the new TD-20. And full-floating seals of increased efficiency guard Dura-Roller life!



New 99.8% efficient Dry-Type air cleaner

For positive "breathing" safety, the full air volume taken in by turbocharging is "dry-cleaned" of 99.8% of its dirt—by the TD-20 Diesel's new dry-type air cleaner. Handy, under-hood horizontal mounting—and transparent, quick-dump collector—greatly simplify servicing. Dash indicator shows "red" when cleaner element needs washing.



New final drive ...new rigidity

New TD-20 final drives have been strengthened to deliver full torque turbocharged power to the tracks. New sprocket drive doweling increases housing rigidity—helps maintain precision component alignment. Other major steps ahead in TD-20 design include: new torque-taking, life-adding bimetallic steering clutch discs; new pivot shaft inner spacer; new hardness of sprocket drive pinion shaft.

International® Construction Equipment

International Harvester Co.,
180 North Michigan Ave., Chicago 1, Illinois

A COMPLETE POWER PACKAGE

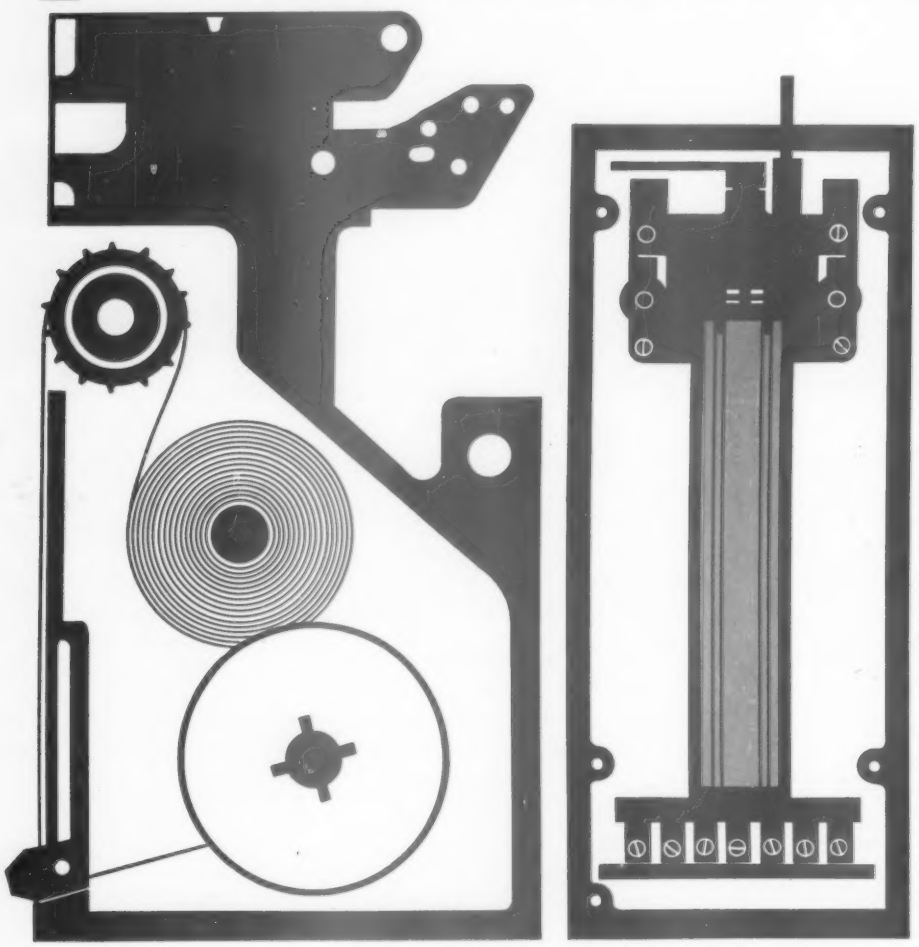
ALL-NEW *ElectroniK 17* POTENTIOMETERS
HAVE NO SLIDEWIRE, NO SLIDEWIRE PROBLEMS

Here is a totally new kind of potentiometer with a totally new kind of measuring system. The *STRANDUCER* replaces the slidewire, and sets a new high standard for potentiometer performance. The new *ElectroniK 17* potentiometers have calibrated accuracy of ±0.25%.

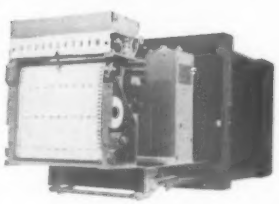
In addition, modular construction makes *ElectroniK 17* instruments easiest of all potentiometers to operate, convert and maintain. Full interchangeability of components cuts service time and spare parts requirements.

You can get *ElectroniK 17* instruments as strip or circular chart recorders or circular scale indicators. You can get electric contact control with up to 8 contacts. All control units are of convenient plug-in type. For all the eye-opening facts about this new class of instruments, call your nearby Honeywell field engineer, or write MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Phila. 44, Pa.—In Canada, Honeywell Controls, Ltd., Toronto 17, Ont.

The unique *STRANDUCER* rebalancing element works on the proven strain gage principle. Both *STRANDUCER* and pen carriage are linked to the potentiometer balancing motor. A change in electrical input causes the balancing motor to change the tension—and electrical resistance—of the *STRANDUCER*, to reposition the instrument pen or pointer. The *STRANDUCER* is unaffected by corrosive atmospheres and has no contactors. It has unusually long life and infinite resolution and is unaffected when the instrument operates in ambient temperatures up to 130° F.



True modular construction saves you time, trouble, money. Three basic modules—case, display and drive—make up the *ElectroniK 17*. The case fits standard 19-inch relay racks. You can remove the door easily and without tools when converting from strip chart to circular chart or circular scale operation. You can pull out the chassis to the service position without tools, and without interrupting operation, or remove it completely. Up to 8 contact control modules can be plugged in for a variety of control possibilities.



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HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world.
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5%	Pt, Pd, or Rh on alumina powder
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5%	Pt or Pd on activated carbon powder
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5%	Pd on $CaCO_3$ or $BaSO_4$ powder
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Help Convert Marginal Wells
into Profitable Producers
with

HALLIBURTON ACIDIZING

If you have a permeability problem—if "tight" zones of limestone or dolomites have made your well a marginal, uneconomic producer—Halliburton Acidizing Services may help you to maximum potential recovery of available oil. In thousands of cases, Halliburton acidizing treatments have increased production to profitable levels, not only in the completion of new wells, but in the stimulation of apparently depleted wells.

Halliburton's highly successful record of acidizing has been largely the result of one principle: getting the right type of acid into the right zone, based on a thorough analysis of the formation requirements. Laboratory examination of cores for permeability and porosity aid in determining the proper acid solution for most promising results; similarly, preliminary investigation may indicate the use of special tools to direct the flow selectively into the formation at one or more locations.

Through the combined efforts of the Halliburton acidizing "team"—stimulation chemicals for your formation's needs, special selective placing tools, competent personnel—your well may be converted from a reluctant reservoir to a profitable producer. Acidizing may be your answer to getting results. Give Halliburton a call! It's the world's most experienced well service organization, with a proven record of field success.

HALLIBURTON ACIDS AND ADDITIVES

STIMULATION AIDS FOR MANY PERMEABILITY PROBLEMS

HALLIBURTON REGULAR ACID

Inhibited hydrochloric acid is the base fluid for the most effective and economical stimulation method for limestone and dolomitic formations. The effective permeability is increased by crevice connecting and enlargement due to chemical action. Hydrochloric acid is usually prepared as a 15% solution by weight for regular acidizing treatment.

HALLIBURTON NON-EMULSIFYING ACID

Composed of regular acid plus a surface active agent to help prevent emulsions from forming during acidizing. Non-emulsifying agents used by Halliburton are also sediment dispersants for a more efficient removal of acid insolubles dislodged by the action of the acid on the formation. A considerable number of these compounds are stocked—some with oil coating properties for the silicate insolubles, others with water wetting characteristics.

HALLIBURTON PENETRATING ACID

Composed of regular acid plus an additive for surface tension reduction. The agent used for penetrating qualities lowers the surface tension of hydrochloric acid to less than one-half of that of regular acid. It can be used in conjunction with non-emulsifying acid.

Its greatest application is in low pressure formations where prolonged "clean-up" time is required because of the "Jamin Effect".

Dilution of the penetrant by interstitial water several times does not increase the surface tension of the spent acid as compared to the live acid.

HALLIBURTON MUD CLEANOUT AGENT (MCA)

The effectiveness of MCA comes from the combination of two components; a blend of organic surfactants, given the trade name Morflo II and a suitable amount of regular acid.

The high concentration of Morflo II, inherent in MCA, imparts unique properties to the removal of flow restrictions. MCA not only shrinks clays but causes particle dispersion. Filter cakes are softened by the Morflo content so that they can be washed away and flushed from the formation.

MCA is a first stage completion acid which can be used in all types of producing formations without the possibility of undesirable reaction products.

HALLIBURTON "HV" ACID

"HV" Acid derives its name from high viscosity. It retards the chemical reaction of acid on limestone formations allowing penetration of unreacted acid a greater distance from the bore hole.

Frequently "HV" Acid, carrying temporary bridging agents, is used as a diverting tool between stages of acid. It is especially useful in open hole work for temporarily plugging thief zones during treatment.

HALLIBURTON "Fe" ACID

This is regular penetrating acid containing a conditioning agent to minimize the undesirable effect of the re-precipitation of dissolved iron salts and oxides during acidizing.

"Fe" Acid is best suited for conditions where abnormal amounts of iron are dissolved by acid prior to its spending on the formation. Such conditions as those associated with disposal and injection wells are instances of its usefulness.

Another use for "Fe" Acid is in producing wells for production improvement where the pipe has a thick coating of iron oxide or salts. Acid will dissolve these iron compounds regardless of the presence of any type of inhibitor used for pipe protection. This iron bearing acid, when spent, exposes flow channels to the plugging action of re-precipitated iron hydroxide. "Fe" Acid aids in preventing this.

CHEMICAL SERVICES

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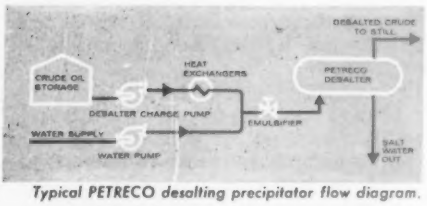
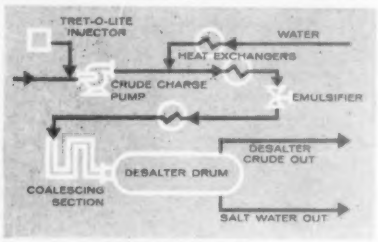
"NEW LIFE FROM OLD OR STUBBORN WELLS—WITH ACIDIZING"

How PETRECO Processes Work...

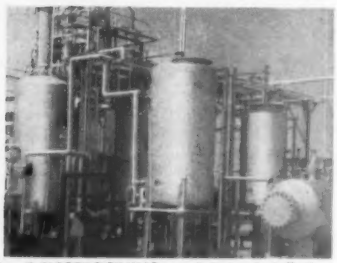
TO IMPROVE PRODUCTS...CUT TREATING COSTS



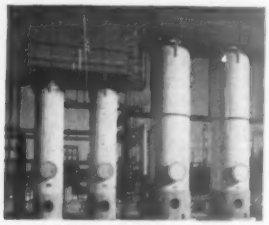
Typical PETRECO desalting precipitator flow diagram.



TRET-O-LITE desalting flow diagram.



Small ELECTROFINING precipitator installation.



BENDER sweetening installation.

** Trademarks, Petrolite Corporation*

PETRECO *Electric Desalting*

The crude charge is pumped through a heat source with temperatures in the 225-275°F. range, then mixed with a small quantity of water and emulsified. Resulting water-in-oil emulsion is then dispersed into high-potential electrostatic field. Powerful coalescing action forces intimate association of impurities (salts and other solids) with water. Water is then quickly and automatically separated and withdrawn. Purified crude continues into refinery flow.

Tret-O-lite *Chemical Desalting

Chemical is injected into suction side of charge pump to assure dispersion. Wash water (about 5% of oil volume) is added to oil-chemical mixture following the charge pump. This oil-chemical-water mix is raised to operating temperature and water-to-oil contact attained by passing through emulsifying valve following heat exchangers. Resulting emulsion then goes through coalescing section where water droplets grow to size that permits separation. Mixture then enters desalting vessel, salt-in-water separates from hydrocarbon phase. Purified crude proceeds to usual distillation equipment.

ELECTROFINING *Precipitators

In this treatment, the distillate is intimately and intensively contacted with a predetermined amount of treating chemical. Controlled intimacy of contact minimizes treating time. The hydrocarbon and treating chemical phases then are rapidly separated by the precipitating action of the strong electrostatic field. With ELECTROFINING* Precipitators, distillate stocks can be treated with caustic to remove acids, hydrogen sulfide, lighter mercaptans, gum-forming components. Cracked stocks can be treated to remove cresols and thiocresols. Sulfuric acid treatment removes sulfur compounds, gum and sediment forming materials, nitrogen bases, arsenic, lead, etc.

BENDER Catalytic Sweetening

Controlled quantities of sulfur, alkali and air are added to the charge stream, then passed through a PETRECO* catalyst bed. The mercaptans are converted to disulfides by oxidation. The resulting product is sweet and non-corrosive. The BENDER process is simple, continuous and automatic.

OTHER PETRECO PROCESSES INCLUDE:

PETRECO *Dehydration
PETRECO *Desaponification
PETRECO *Sediment Separation

FOR MORE INFORMATION on any of these treating processes, contact your local Petreco service engineer, or write...

AR-60-2

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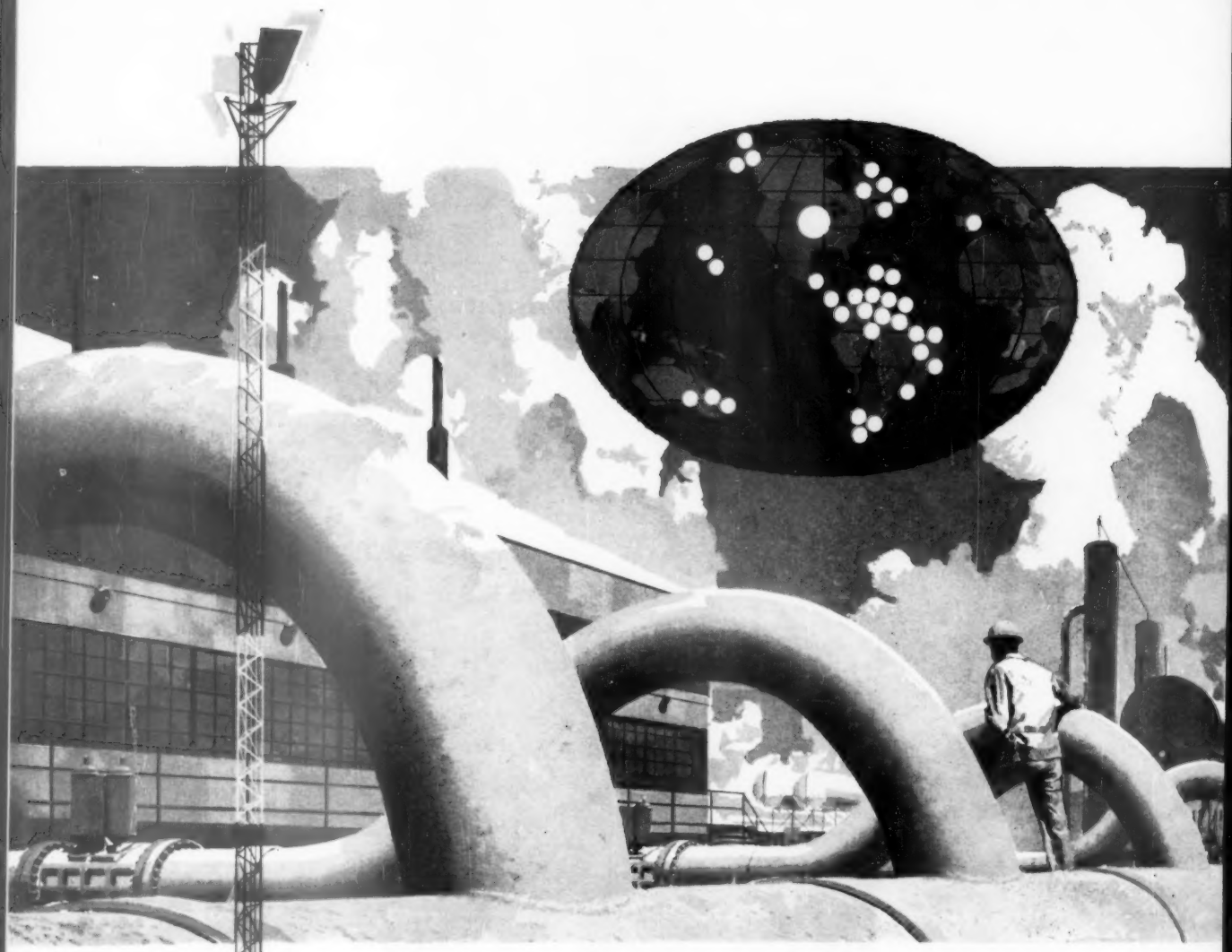

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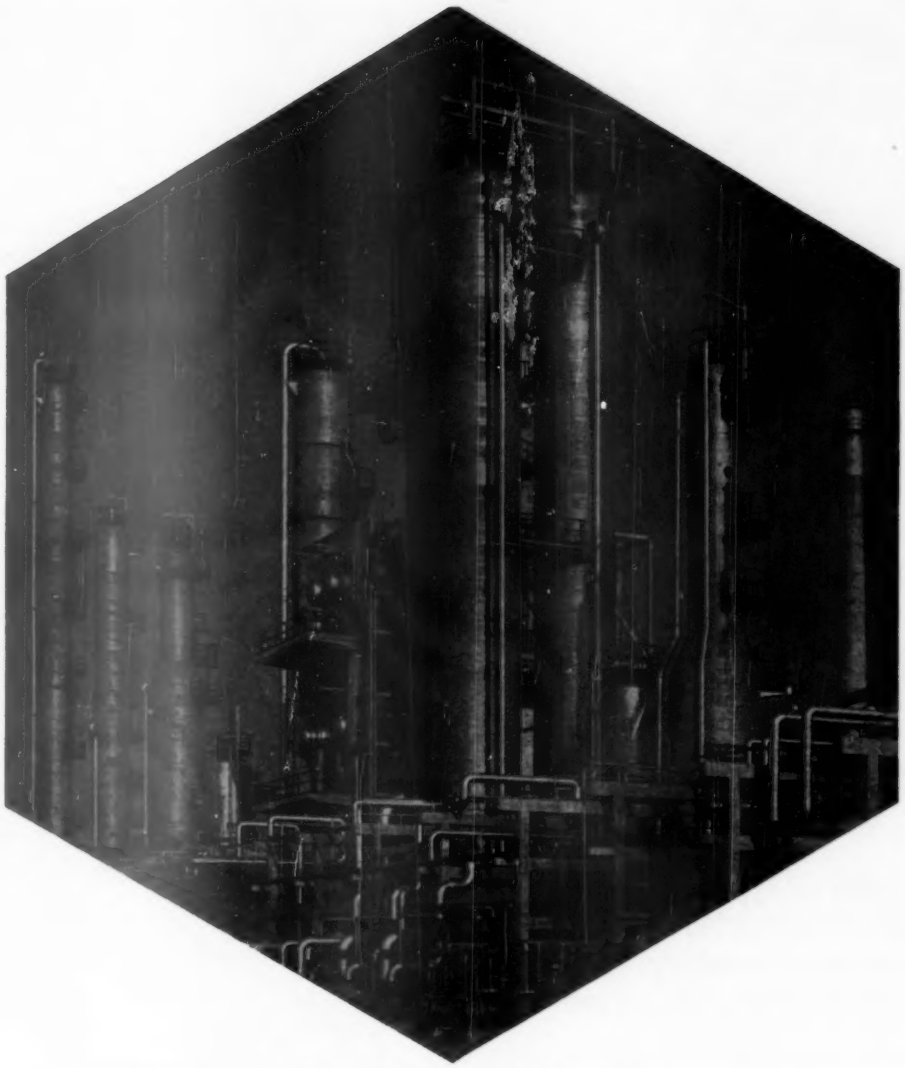


produce petrochemicals profitably with UDEX

UDEX® is being widely used by refiners throughout the world for profitable production of high purity petrochemical intermediates, benzene, toluene and xylenes. Udex aromatics meet the highest standards of purity. In addition, Udex is a valuable process for separating high and low-octane gasoline fractions to control the quality of finished gasolines.

Udex provides ideal market flexibility by enabling refiners to make products that meet changing product demands. Low utility consumption and low solvent costs make Udex unusually economical to operate.

Udex has operational flexibilities too. Feed to a Udex unit can vary widely in both quantity and composition, yet the stringent specifications of the product output will be maintained. Originated by Dow Chemical Company, the Udex extraction process was developed and is made commercially available by UOP.

UOP offers a wide range of petroleum and petrochemical processes to refiners everywhere in the free world. A variety of technical services are also available to insure the profitable performance of these processes. Let UOP engineers evaluate your processing needs now.

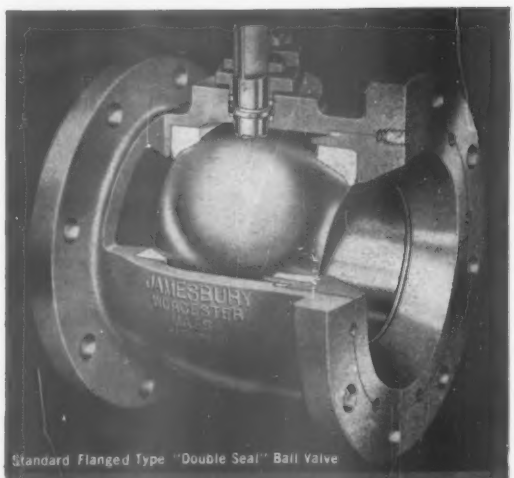
WHERE RESEARCH TODAY
MEANS PROGRESS TOMORROW

UOP®

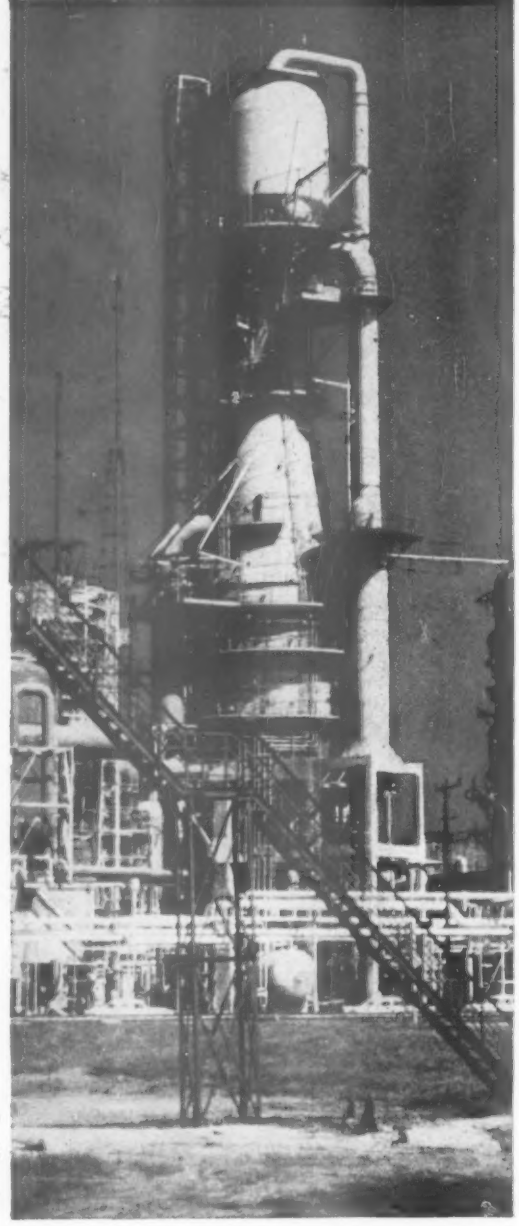
UNIVERSAL OIL PRODUCTS COMPANY
30 Algonquin Road, Des Plaines, Illinois, U.S.A.

A Significant Announcement to
the Refinery and Petrochemical Industries

jamesbury "Double-Seal"™ TYPE DZ FIRE*SAFE†™ BALL VALVES*



Standard Flanged Type "Double Seal" Ball Valve



Available for application in a wide range of installations in the heart of the refinery processing areas and in petrochemical and natural gasoline processing services.

Proved in long-term pre-testing and in full scale processing installations, the Jamesbury "Double-Seal" FIRE SAFE Ball Valve brings the advantages of full flow, quarter-turn positive shut-off, low torque and no lubrication to "the heart of the process" in these industries.

Complete size range and materials data available on request.

Write for Jamesbury Refinery Brochure for further details.

JAMESBURY CORP.

92 New Street, Worcester, Mass.

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*PATENTED
†pat. app. for

Tanks for latex storage coated with Tube-Kote TK-2, baked-on phenolic

TUBE-KOTE®

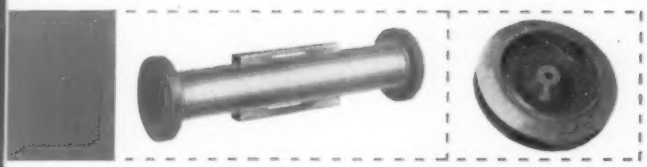
Solves your corrosion and product contamination problems

THE INDUSTRY'S most complete selection of coatings including epoxies, polyurethanes, teflons, pentons, plastisols and many specialized formulas is offered by Tube-Kote, Inc. Modern facilities, painstaking workmanship, and years of experience combine to make each Tube-Kote application superior in every way.

Applications may be made in the Tube-Kote plant (recommended in most cases) where full laboratory control may be exercised, or may be made by Tube-Kote technicians in the field using portable application and curing equipment. In some instances the coatings may be supplied in bulk for application by your own crews using ordinary equipment.

You can count on a Tube-Kote coating to meet even the most critical demands of your industry. Tube-Kote research is constantly testing new materials for your more specialized uses.

Discuss your particular coating requirements with a Tube-Kote representative.



A 6-inch flow meter lined with **Penton** by Tube-Kote's unique process

A 72-inch die cast aluminum impeller treated with Tube-Kote to resist corrosive vapors

TUBE-KOTE FIRST NAME IN CORROSION RESISTANCE

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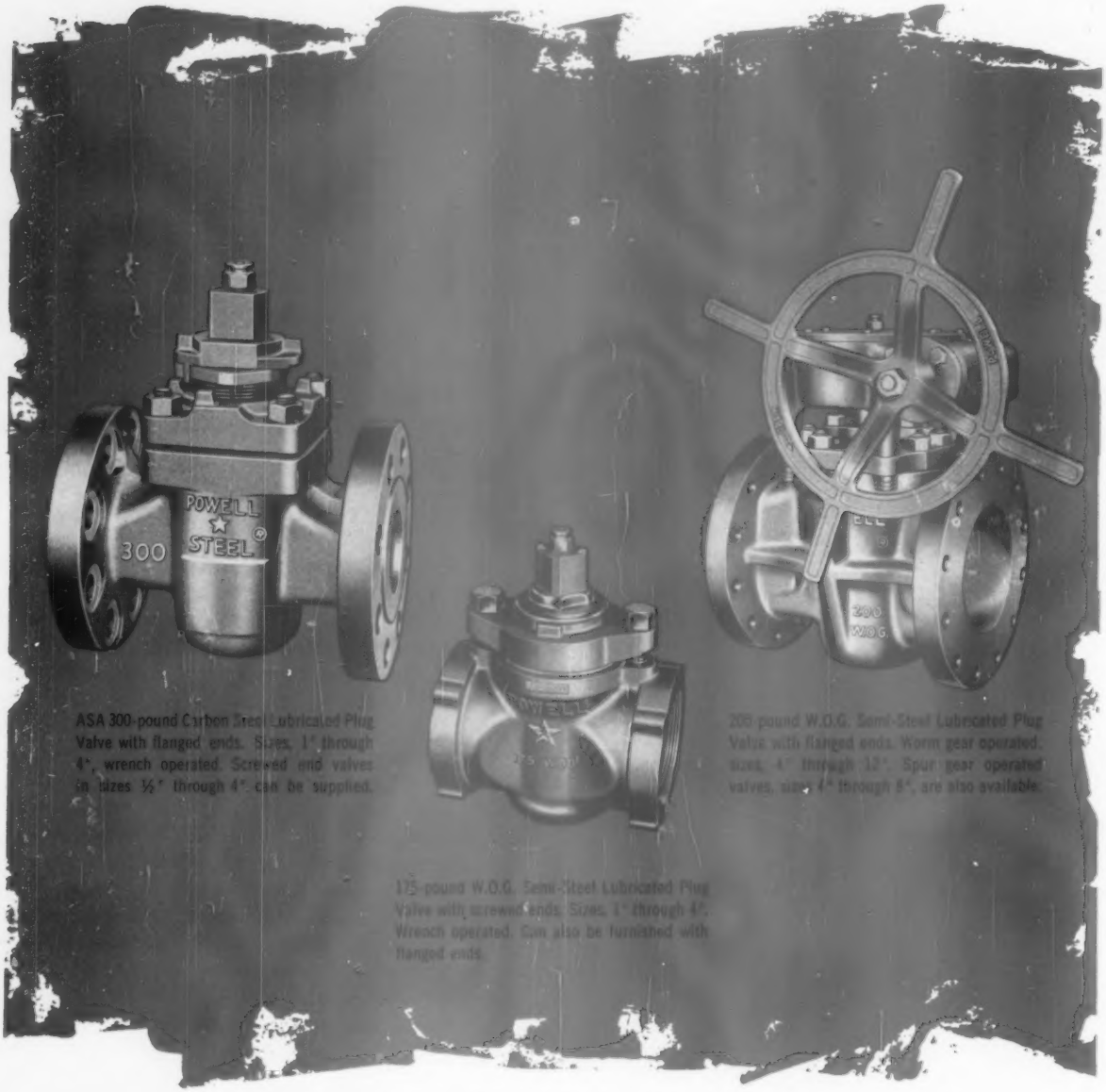
POWELL PERFORMANCE PAYS OFF

It is a matter of record, in refineries everywhere, that Powell valve performance really is paying off.

And equally important is the fact that whether you need valves to control the flow of water, oil, gas, air, steam or corrosive fluids—available in steel, bronze, iron or alloys—Powell has them.

You'll find every Powell valve is designed by engineers long experienced with the industry's valve requirements . . . and built by craftsmen who take pride making a valve you can count on.

So, by filling your flow control needs quickly, with truly reliable valves from one source of supply, you too, can be sure of valve performance that will pay off. For further information or assistance with special problems, contact your nearby Powell valve distributor or write The Wm. Powell Company, Cincinnati 22, Ohio.



ASA 300-pound Carbon Steel Lubricated Plug Valve with flanged ends. Sizes, 1" through 4", wrench operated. Screwed end valves in sizes ½" through 4" can be supplied.

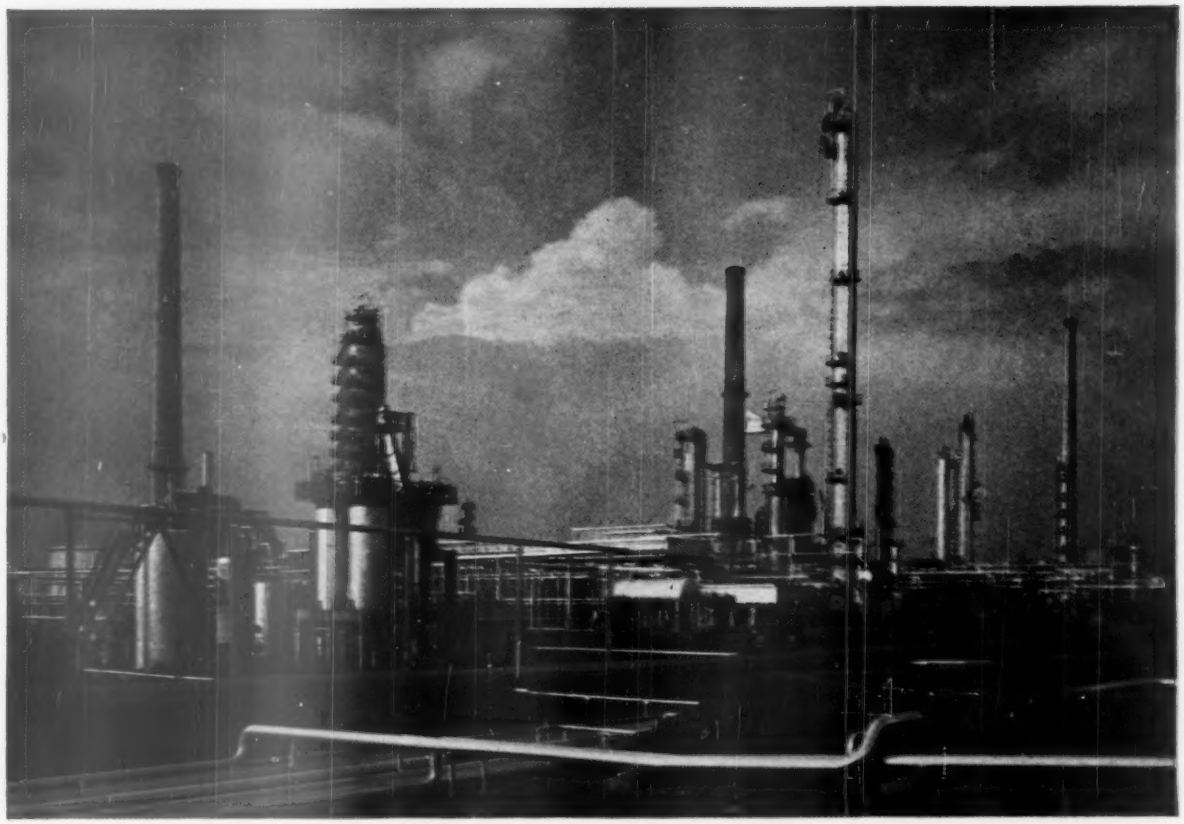
175-pound W.O.G. Semi-Steel Lubricated Plug Valve with screwed ends. Sizes, 1" through 4". Wrench operated. Can also be furnished with flanged ends.

200-pound W.O.G. Semi-Steel Lubricated Plug Valve with flanged ends. Worm gear operated. sizes, 4" through 12". Spur gear operated valves, sizes 4" through 8", are also available.

115th year of manufacturing industrial valves for the free world

POWELL PETROLEUM **VALVES**

THE WM. POWELL COMPANY CINCINNATI 22, OHIO



Esso Petroleum Company, Limited, 100,000 BPSD refinery at Milford Haven, Wales. Engineering-contractor: Foster Wheeler

The Invisible 100,000 BPSD Refinery

This sky-silhouetted partial view of the new Esso Petroleum Company Limited 100,000 BPSD refinery at Milford Haven certainly appears to be quite visible. But the fact is that it is virtually invisible from the nearest highway or from the nearby sea. For important economic and civic considerations, the installation was in effect designed *into* the rolling hills of Milford Haven. Fully automated, the refinery produces gasoline and fuel oil in six process sections. As many as ten motor fuel components may be blended by remote control.

Shown above on the left are the crude distillation facilities and on the right, the powerformer processing area. A 500 million Btu/hr Foster Wheeler direct-fired heater . . . one of the largest of its type . . . serves the crude distillation unit. Facilities also include a T-shaped marine terminal extending 3500 ft. from the shore reaching a water depth of 50-70 ft. to accommodate the largest super-tankers.

To integrate this "grass roots" refinery with surrounding communities, over 75 storage tanks and spheres were placed on terraces and heater stacks were breeched into three 300 ft. main stacks to eliminate air pollution. To guard against water pollution, a separator with a 10 million gallon pond was constructed.

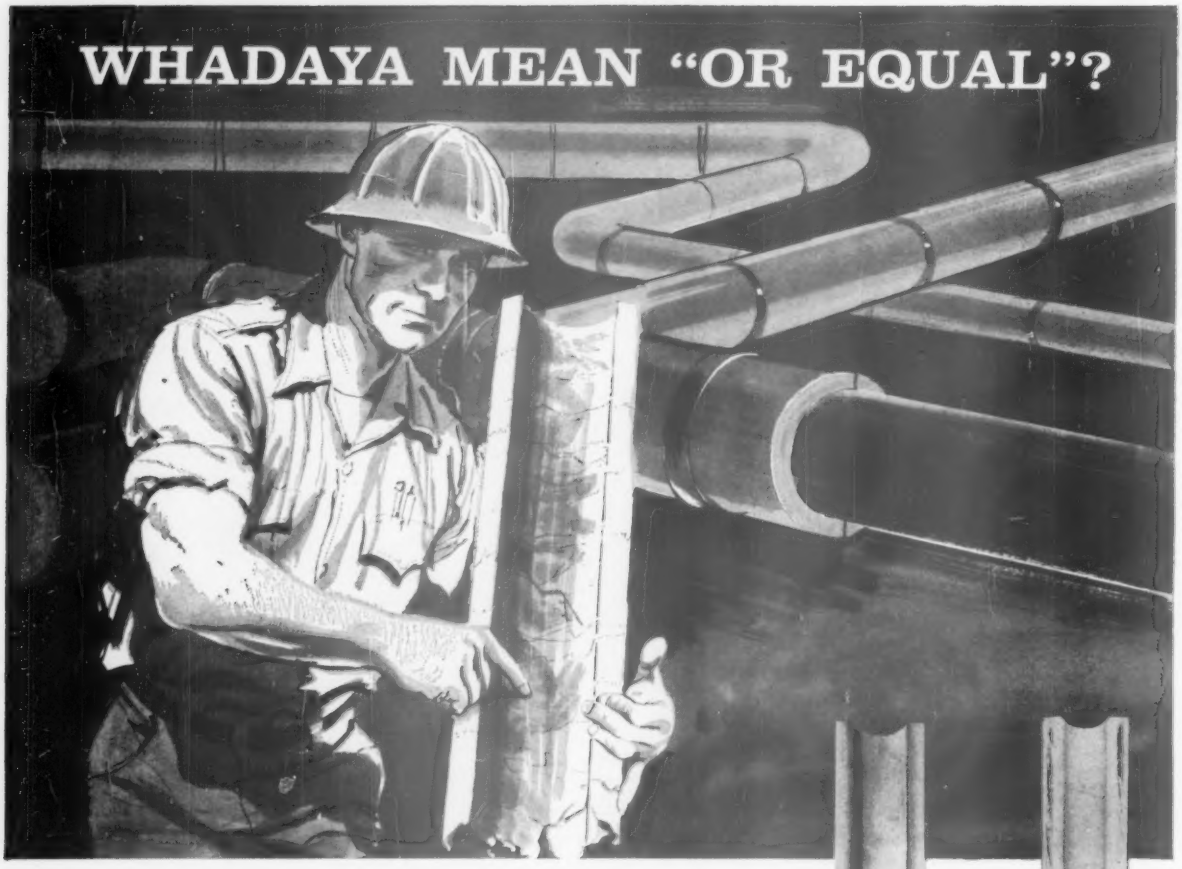
As in more than 800 process installations before this one, Foster Wheeler's engineering and construction services have provided the experience, ingenuity and technical competence needed to meet unusual project requirements. Here is more evidence of Foster Wheeler's ability to serve you, whatever your requirements . . . large or small . . . anywhere in the world.

Heat Engineered products, plants and processes . . . for the world's industrial progress.

FOSTER WHEELER

NEW YORK TORONTO LONDON PARIS MILAN TOKYO

WHADAYA MEAN "OR EQUAL"?



UNIBESTOS... No-Shrink, No-Shock!

No matter how carefully specifications are worked out, the term *"or equal"* can mean trouble . . . big trouble. Take insulation shrinkage and shock for example. Hard to predict, hard to account for, they mean heat loss and replacement that can put a serious crimp in any profit picture.

That's the very reason why Unibestos *"no-shrink," "no-shock"* insulation is worth more to you. Yet it sells at competitive prices. Prove to yourself how Unibestos saves you money by eliminating shrinkage, breakage, and thermal shock. See how it defies fumes, acids and moisture; cuts application time and cost, and guarantees real insulating efficiency.

Available in a full range of standard pipe sizes and in block form. Single thicknesses to five inches. Specials to 44" O.D. in half sections.

Write today, on your letterhead, for Bulletin No. 65610.

UNIBESTOS AMOSITE INSULATION | **ORDINARY ASBESTOS INSULATION**

What's the answer to Unibestos superiority? It's the extra-long fibered *Amosite* asbestos, plus an exclusive manufacturing process that assures top insulating efficiency *plus* high mechanical strength. In use month after month, year after year, you'll have no shrinkage problem, as Unibestos goes on and on.

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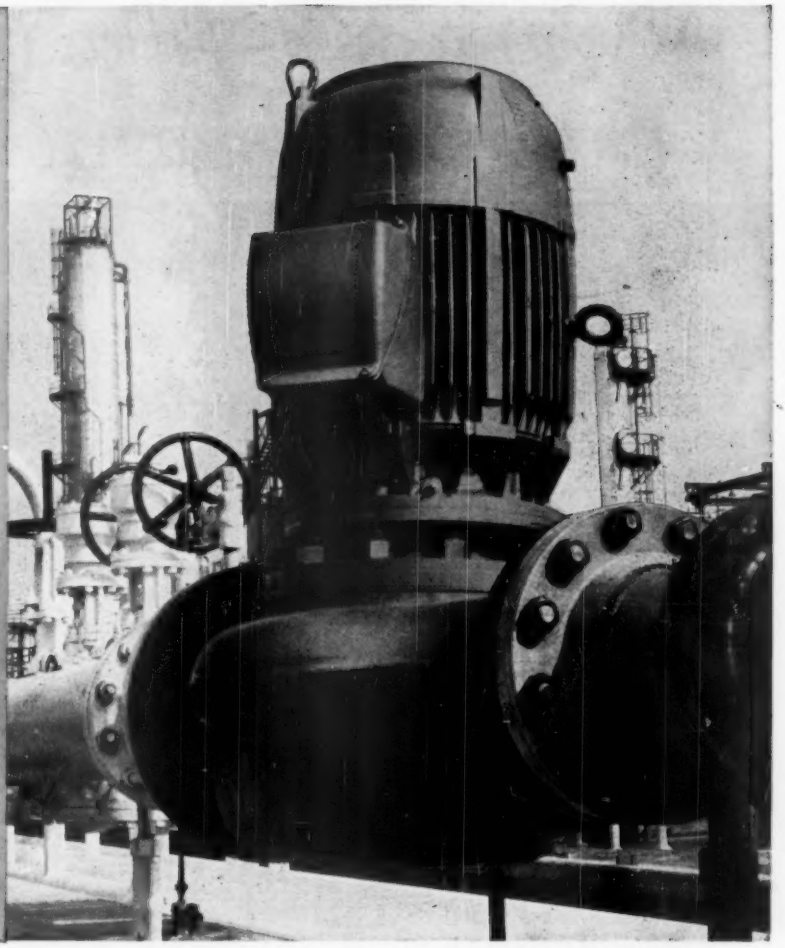
UNION ASBESTOS AND RUBBER COMPANY • FIBROUS PRODUCTS DIVISION

DEPT. 267, Bloomington, Illinois

Designed for best Economic Balance

NEW PACIFIC TYPE SPM

Pipe-Mounted Transfer and Process Pumps



ECONOMIC BALANCE—an optimum relationship between capital and continuing costs of equipment is especially true in process pumps, whose lifetime operating and maintenance costs may be many times the initial investment.

Here are the factors of best economic balance in process pumping offered by Pacific's new pipe-mounted centrifugal pumps:

LOWER FIRST COST: Fewer (only six functional) parts • No separate pump bearings or brackets • High degree of interchangeability—minimum inventory.

LOWER INSTALLATION COST: No baseplate or foundation required • No field alignment necessary • Integral drive—no motor coupling • Flange-mount and connect to power—that's all.

LOWER MAINTENANCE COST: Standardization of seals and shaft-mounted parts • Ready access, even in closest quarters, for field service, *or* • Easily demounted as a unit for shop maintenance.

LOWER OPERATING COST: Each pump impeller designed for peak efficiency in a given application, *or* • Where low power costs permit, orifice control can be provided to adapt one pump size to a wide variety of applications.

There is only one *true* cost of a process pump. It's the *overall*, lifetime cost of the unit. Make a date with your Pacific Pump representative to discuss the entire pump standardization plan in your plant. He has the broadest line of any in the process field . . . and the experience to match.

PACIFIC

CENTRIFUGAL PUMPS FOR PETROLEUM, CHEMICAL, UTILITY & GENERAL INDUSTRIES
OIL WELL PUMPS

DRESSER INDUSTRIES INC.

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Write for New Type SPM Bulletin 142

PACIFIC PUMPS

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HUNTINGTON PARK, CALIFORNIA, U.S.A.

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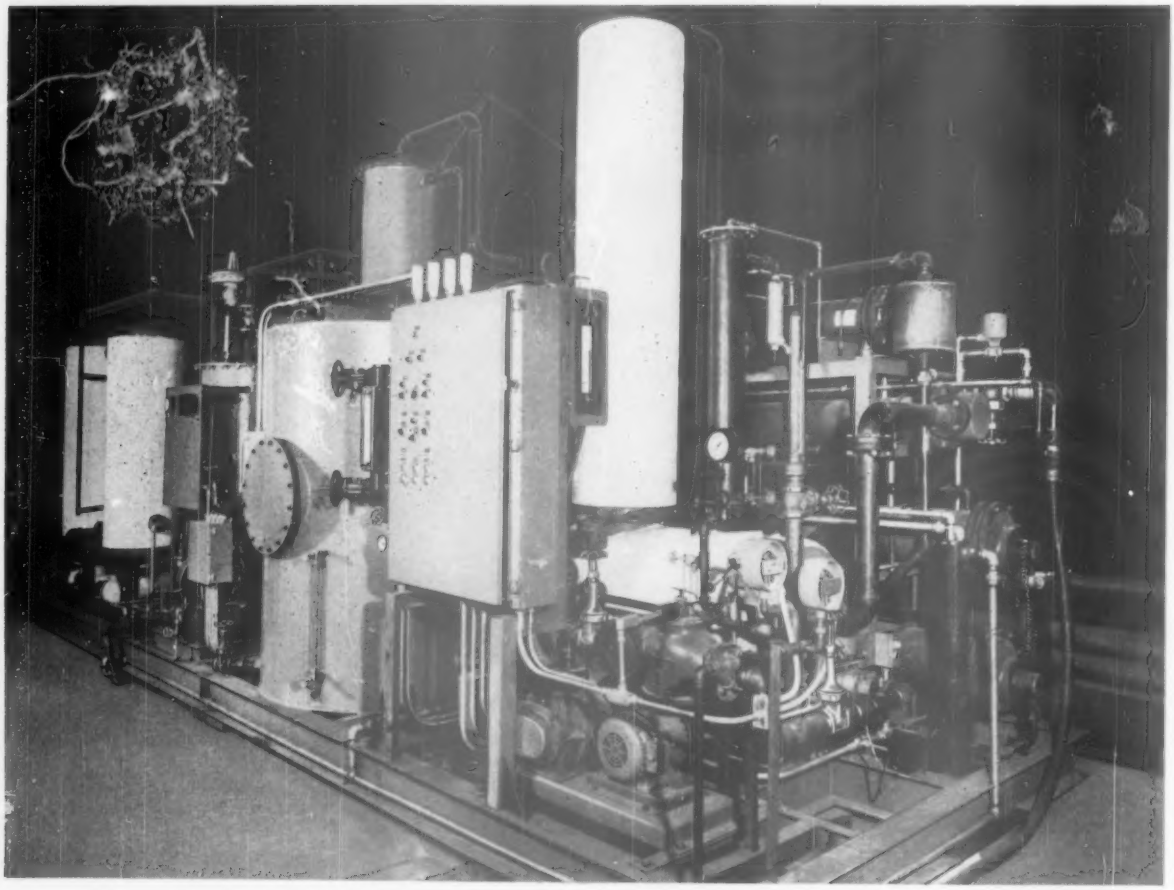

...our Atmosphere Generator Systems incorporate JENKINS VALVES"

Gas Atmospheres, Inc., Cleveland

"A reputation for reliability has made us the largest exclusive producer of packaged gas systems for industry. Care in choosing our components has helped build that reputation. We incorporate Jenkins Valves in our systems because our customers know there's nothing better to be had." Gas Atmospheres, Inc. of Cleveland and scores of other producers of industrial equipment employ Jenkins Valves to prevent trouble and costly maintenance for their customers. At the same time, they build respect for the quality of their products.

Of course, valves of less quality can be had for a little less money. But the real money-saving truth is that Jenkins Valves, so widely known for reliability and long life, COST NO MORE than any good valves. Jenkins Bros., 100 Park Avenue, New York 17.

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MOST TRUSTED TRADEMARK IN THE VALVE WORLD

VALVES

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Descale boilers, heat exchangers, condensers

easily, more safely with non-fuming Dry Acid Cleaners based on Du Pont Sulfamic Acid

EASIER TO USE

Just scoop the dry acid cleaner from lightweight, disposable drum into make-up tank. Often can be added directly to steam-generating, condensing and similar equipment . . . no elaborate apparatus or specially trained personnel required.

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These cleaners are dry, non-fuming powders. No danger of broken carboys, spattered liquids, corrosive fumes with sulfamic-based cleaners.

ECONOMICAL

1 lb. of dry acid cleaner does the job of 1.5 lbs. of hydrochloric acid. You'll save on shipping, handling and storage costs.

LESS CORROSIVE

Sulfamic acid is less corrosive than hydrochloric acid; on brass, 60% less; on steel—70%; copper—85%; aluminum—80%. This low corrosion rate permits use with the equipment's own pump. And, with the proper inhibitor, it can be used safely on galvanized steel.

for more information,
mail coupon for free booklet and names of formulators who offer these compounds

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Please send me quick facts bulletin on Dry Acid Cleaners, names of formulators offering cleaners based on Sulfamic acid.

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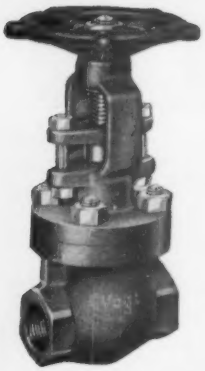

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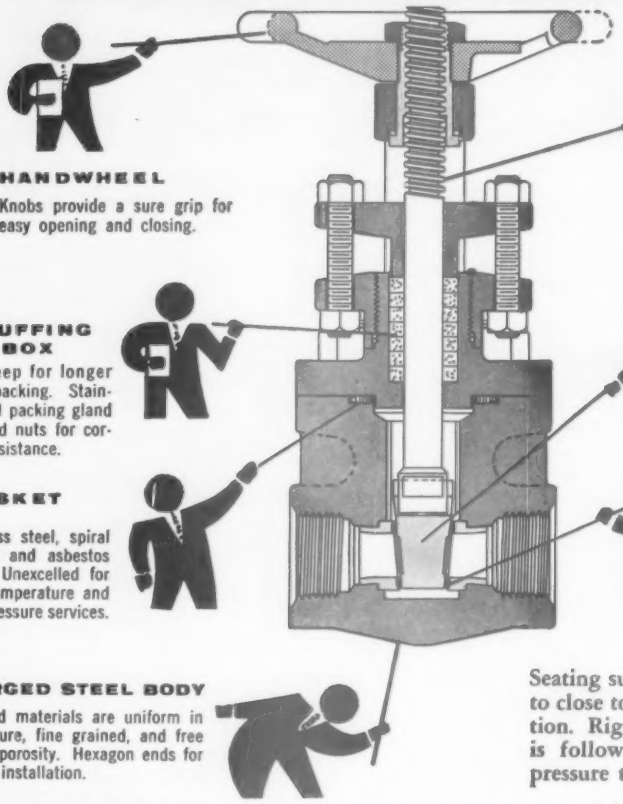
2000 POUNDS COLD, W.O.G.
SIZES ¼" THRU 2"

A NEW Vogt

with 7 superior features



1 HANDWHEEL

Knobs provide a sure grip for easy opening and closing.

2 STUFFING BOX

Extra deep for longer life of packing. Stainless steel packing gland studs and nuts for corrosion resistance.

3 GASKET

Stainless steel, spiral wound, and asbestos filled. Unexcelled for high temperature and high pressure services.

4 FORGED STEEL BODY

Forged materials are uniform in structure, fine grained, and free from porosity. Hexagon ends for easy installation.

5 STEM

13% Chrome stainless steel. A special high melting point alloy yoke nut assures prolonged wear resistance.

6 WEDGE

13% Chrome stainless steel of approximately 500 Brinell for longer wear.

7 SEATS

13% Chrome stainless steel, hard faced with *HAYNES STELLITE or equivalent for stubborn resistance to seat wear.

Seating surfaces are precision machined to close tolerances for drop tight operation. Rigid inspection of finished parts is followed, after assembly, by final pressure tests of body and seats.

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FORGED STEEL

VALVES

a christmas tree is only as strong as its weakest seal

Rector makes the hook-up that is Sealed with Steel throughout

Rector wellhead equipment is designed to insure a leak-proof seal at all connections. Compare Rector's metal-to-metal seal features with any equipment on the market using resilient packing between casing and tubing strings. The Rector principle of reinforcing temporary organic packing with a permanent ring of steel insures a positive leak-proof completion every time. Rector's built-in welding ring coupled with an API ring gasket is easy to install, immune to corrosion inhibitors, will not flow under high pressure or temperature, will not freeze or contract under low temperature, will not burn out, and never requires maintenance or replacement.

There are no weak links in your completions, when you specify Rector equipment at your favorite supply store, or from your Rector representative.

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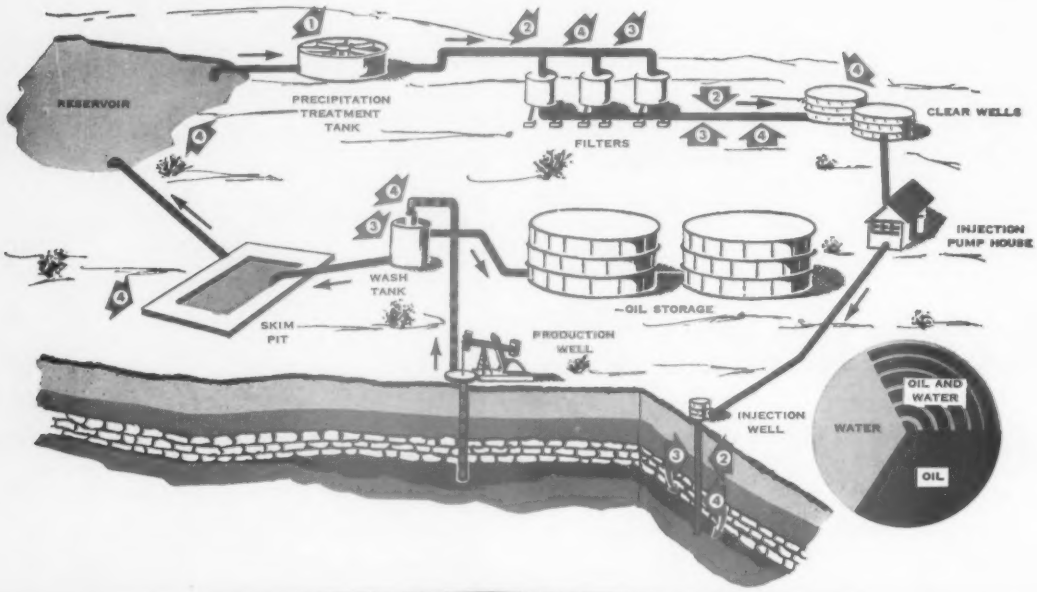
Continuous High Input with *Visco*® Water Flood Treatments



1 TURBIDITY REMOVAL
Clarification of raw water with efficient coagulants assures better floc formation, faster settling of solids.

2 CORROSION CONTROL
Polyphosphates or organic film forming inhibitors protect pipe lines and equipment against corrosive attack.

3 SCALE PREVENTION
Stabilizing treatments keep scale-forming salts in solution and maintain clean lines and an open formation with large water input volume.

4 MICROBIOLOGICAL CONTROL
Microbiological treatments help maintain clean equipment and an open formation by controlling slime, algae and sulfate reducing bacteria.

Treatments for water flood operations add up to continuous high input, low pumping costs, elimination of acidizing and back flushing and lower over-all operating and maintenance costs. Check the diagram above for points where the Visco Chemicals and Services work to improve water flood efficiency . . . Your Visco Field Service Man will be glad to work with you on any problems you have. His experience is backed by the entire facilities and skills of the world's largest water treatment organization.

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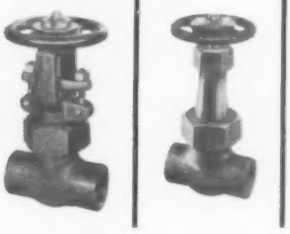
Visco® CONSISTENTLY EFFICIENT OIL INDUSTRY CHEMICALS

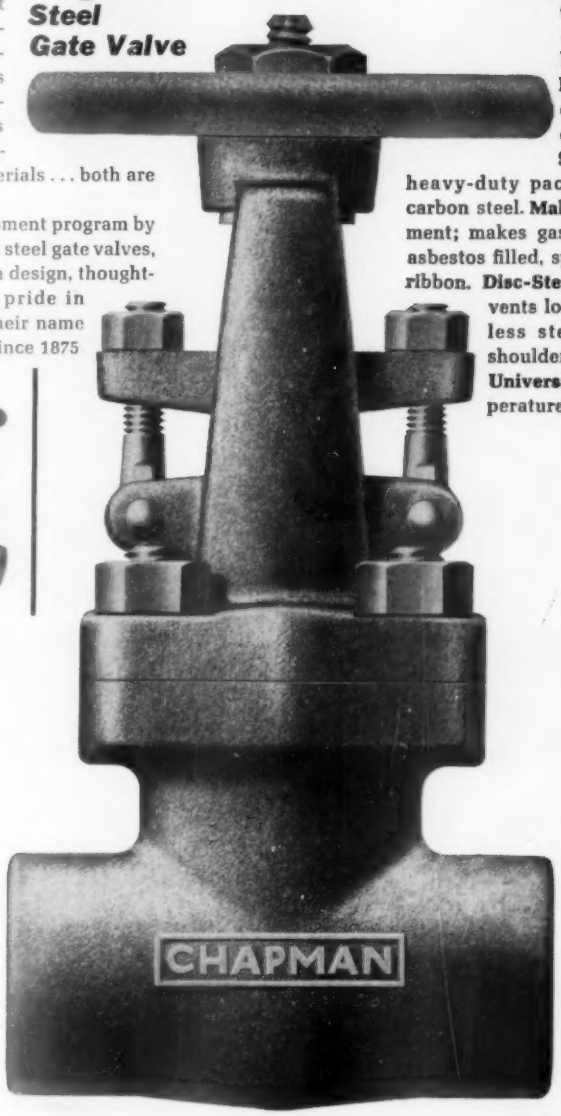
ENGINEERED TO "TAKE CARE OF ITSELF"...

In valves, "forgetability" is a true measure of worth. "Forgetability" is defined in terms of those qualities which allow a valve, once installed, to be almost forgotten. It results from perfection of performance, and year-after-year dependability; combined with less than moderate maintenance requirements. These characteristics are the outgrowth of knowledgeable design and excellence of materials . . . both are tradition with Chapman Valves.

Product of an all-inclusive development program by Chapman, the *originators* of forged steel gate valves, the 960B represents the integrity in design, thoughtful selection of materials, and pride in workmanship which have made their name synonymous with quality valves since 1875

New Chapman 960B Rugged-Duty Forged Steel Gate Valve





Wheel . . . cast ductile iron. **Stem** . . . heat-treated stainless steel; backseats in bonnet. **Yoke Sleeve** . . . corrosion resistant Chapman alloy CV510. **Follower and Gland** . . . socket and ball type: bind-proof follower; stainless steel gland. **Eyebolts** . . . stainless steel; swing-down design. **Yoke** . . . "bowlegged" design for exceptional hand room. **Stuffing Box** . . . bigger, with special, heavy-duty packing **Bonnet and Body** . . . forged carbon steel. **Male-Female Joint** . . . for precise alignment; makes gasket blowout impossible. **Gasket** . . . asbestos filled, spiral-wound, flexible stainless steel ribbon. **Disc-Stem Connection** . . . sliding joint prevents load transfer. **Disc** . . . hardened stainless steel; guided travel. **Seat Rings** . . . shoulder type, Stellite-faced stainless steel. **Universal Trim** . . . all standard services; temperatures to 1000°F; pressures to 2000 psi.

PRESSURES TO 2000 PSI ☐ TEMPERATURES TO 1000 F ☐ SIZES ¼ TO 2 IN. ☐ UNIVERSAL TRIM FOR ALL SERVICES

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MANUFACTURING COMPANY ■ INDIAN ORCHARD, MASSACHUSETTS ■ A SUBSIDIARY OF CRANE CO.

There are many Styles of Diamond Bits . . .

. . . because Christensen "custom engineers" diamond bits to overcome particular problems. On that next drilling, coring, reaming, or fishing job, ask your nearest Christensen office about diamond bits designed for you

"Less cost per foot"

CHRISTENSEN DIAMOND PRODUCTS

MAIN OFFICE AND PLANT 1937 SOUTH 2nd WEST

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SERVICE FROM WORLD-WIDE SALES OFFICES AND MANUFACTURING PLANTS

NEW Butterfly Valve!

MATCHLESS LUNKENHEIMER QUALITY

FIG. 4026N

Complete Valve with Ends on Casting.
2"-6".
Screwed End.

FIG. 4150N

(Rubber-Lined: Fig. 4151R) Valve Elements Only.
2"-18". Screwed, Welded, Grooved, or Flanged Ends Supplied Separately to Fit Your Pipe Connections.

L-361-23

W. P. 150 psi.

- QUICK OPENING
- POSITIVE CLOSURE
- NICKEL-PLATED CAST IRON
- STAINLESS STEEL TRIM
- "O" RING SEALS

New Lunkenheimer Butterfly Valves are compact and lightweight, easy to install on any line in a fraction of the space required by standard gate or plug valves. A quarter-turn of the stem opens the disc full or closes it tight. No lubrication is required, and "O" Ring seals provide positive shut-off in either vacuum or pressure service. These new Butterfly Valves are made to traditional Lunkenheimer standards of quality. WRITE for new Catalog 613 or call your Lunkenheimer distributor today for full information on the new Lunkenheimer Butterfly Valve line . . . available now for immediate delivery.

LUNKENHEIMER®

THE ONE Great NAME IN VALVES

THESE ARE PAGES 6 & 7 OF THE

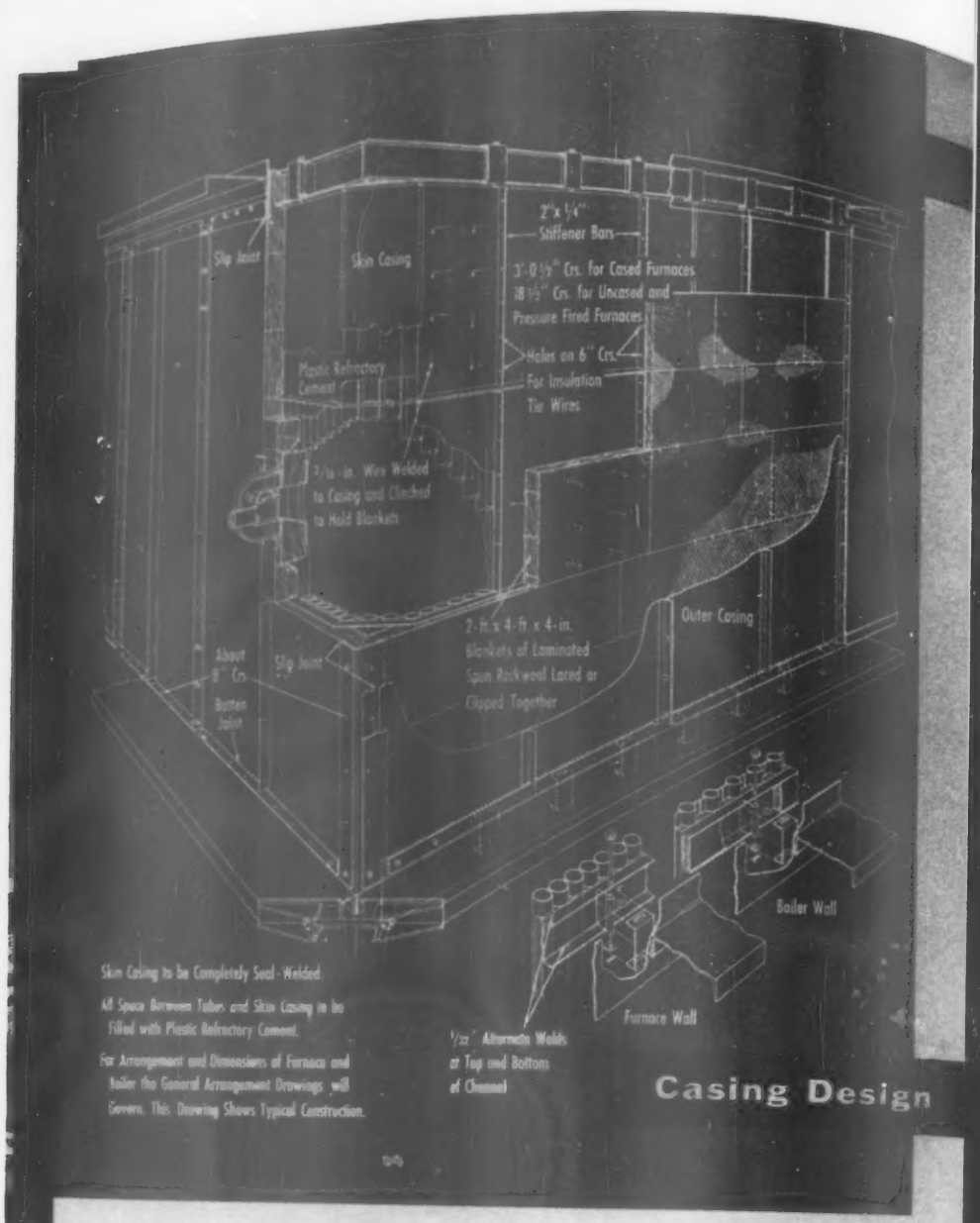
2"x 1/4" Stiffener Bars
Slip Joint
Skin Casing
3'-0 1/2" Crs. for Cased Furnaces
18 1/2" Crs. for Uncased and Pressure Fired Furnaces
Holes on 6" Crs. For Insulation Tie Wires
Plastic Refractory Cement
3/16-in. Wire Welded to Casing and Clinched to Hold Blankets
2-ft. x 4-ft. x 4-in. Blankets of Laminated Spun Rockwool Laced or Clipped Together
Outer Casing
About 8" Crs.
Slip Joint
Butten Joint
Boiler Wall
Furnace Wall
1/2" Alternate Welds at Top and Bottom of Channel
Skin Casing to be Completely Seal-Welded.
All Space Between Tubes and Skin Casing to be Filled with Plastic Refractory Cement.
For Arrangement and Dimensions of Furnace and Boiler the General Arrangement Drawings will Govern. This Drawing Shows Typical Construction.
Casing Design

Fig. 7—Details of construction for pressurized furnaces for C-E Boilers designed for waste regenerator gas firing.

6

For the whole fact-filled catalog, write . . .

20-PAGE C-E CO BOILER CATALOG

C-E Design for CO Boilers

Combustion Engineering CO Boilers are of advanced design, yet conventional in appearance, and use the time-tested C-E Tangential Burner in the four corners of the furnace. They require no specialized or complicated means to burn the lean, moist, toxic gas from a catalyst regenerator. Utilization of furnace volume is so efficient that combustion rates of over 40,000 Btu per cu ft and higher are practical.

These units are designed for pressurized furnace operation. The absence of induced draft fans assures minimum air pressure loss and fan horsepower requirements.

The [illegible]-cased furnace wall construction with inner (skin) casing welded to tangent wall tubes is designed for cubical expansion of pressure parts. With the skin casing in intimate contact with the tubes, its temperature at any point is the same as the tube temperature. Thus, though the entire furnace expands cubically, there is no relative expansion between the tubes and the skin casing. For this reason the skin casing can be completely welded. This construction is carried over to the [illegible] economizer side walls where the tubes are finned. The conventional rectangular furnace allows the preferred arrangement of boiler and superheater with uniform heating surface and gas-passage area per foot of furnace width. It also provides relatively quiet burner positions, assuring positive, stable ignition. Further, the rectangular shape permits an efficient system of platforms and stairways for observation and access. Heating surfaces are disposed to recover the maximum amount of heat with a minimum of baffling. The gas velocities through the boiler are high enough to prevent excessive settling out of catalyst, yet sufficiently low to avoid excessive erosion.

At a specified steam output, the circulation conditions in a CO boiler, when firing regenerator waste gas and auxiliary fuel, are entirely different than when firing auxiliary fuel alone. For this reason, the circulating system of C-E Boilers using these fuels is designed to handle the flows of water and steam for both these extreme conditions. Furthermore, the drum internals are designed to maintain the specified purity regardless of the fuel fired.

Either a C-E continuous finned tube economizer or a vertical tube, drum-type economizer is located after the boiler section. The finned economizer is normally selected when substantial quantities of supplementary fuel will be fired and higher efficiency can be justified. The vertical tube, drum-type is a more compact design suitable for minimum load CO boilers.

A notable feature of the C-E design is the unique arrangement of integral by-pass and [illegible] seal tanks in the lower portion of the stack. These tanks provide for safe, quick changeover from the stack by-pass to the burner supply duct. No by-pass stack with additional connecting ducts and breeching is required for handling the flow of the waste gas.

C-E Boilers for firing waste gas from catalytic regenerators are completely coordinated units combining boiler, furnace setting, fuel burning and forced draft equipment. This provides the extra advantage of having one contract, one guarantee and one responsibility. They are not necessarily the lowest in first cost, but the economies accruing from superior design, construction, reliability and overall operating cost will quickly offset any price difference between the least expensive boiler and the Combustion Engineering CO Boiler.

The fact that C-E Boilers have been selected to meet the exacting performance standards of so many of the nation's largest electric utility power stations is evidence of the design and construction you can expect to find in any boiler, large or small, that bears the Combustion name plate.

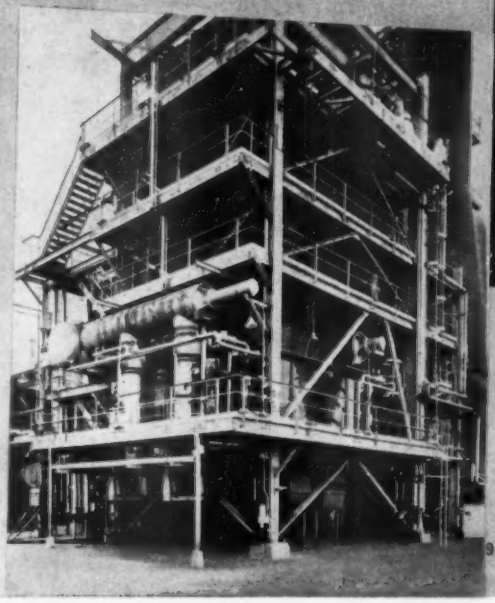

FIG. 6—C-E Boiler for waste regenerator gas firing in an oil refinery on the West Coast. The sectional side arrangement of this boiler appears on page 8.

C-290

COMBUSTION ENGINEERING

210 Madison Avenue, New York 16, N. Y.

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Probably everybody who owns, operates, or maintains trucks knows that an Eaton 2-Speed Axle doubles the number of gear ratios provided by a conventional transmission—that it gives drivers the *right* ratio for every operating condition.

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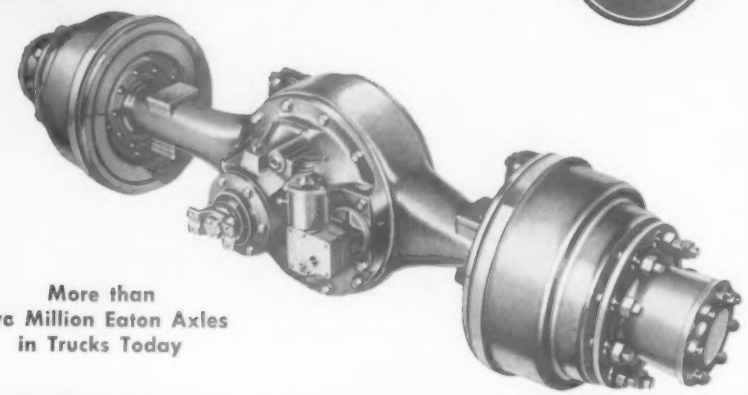

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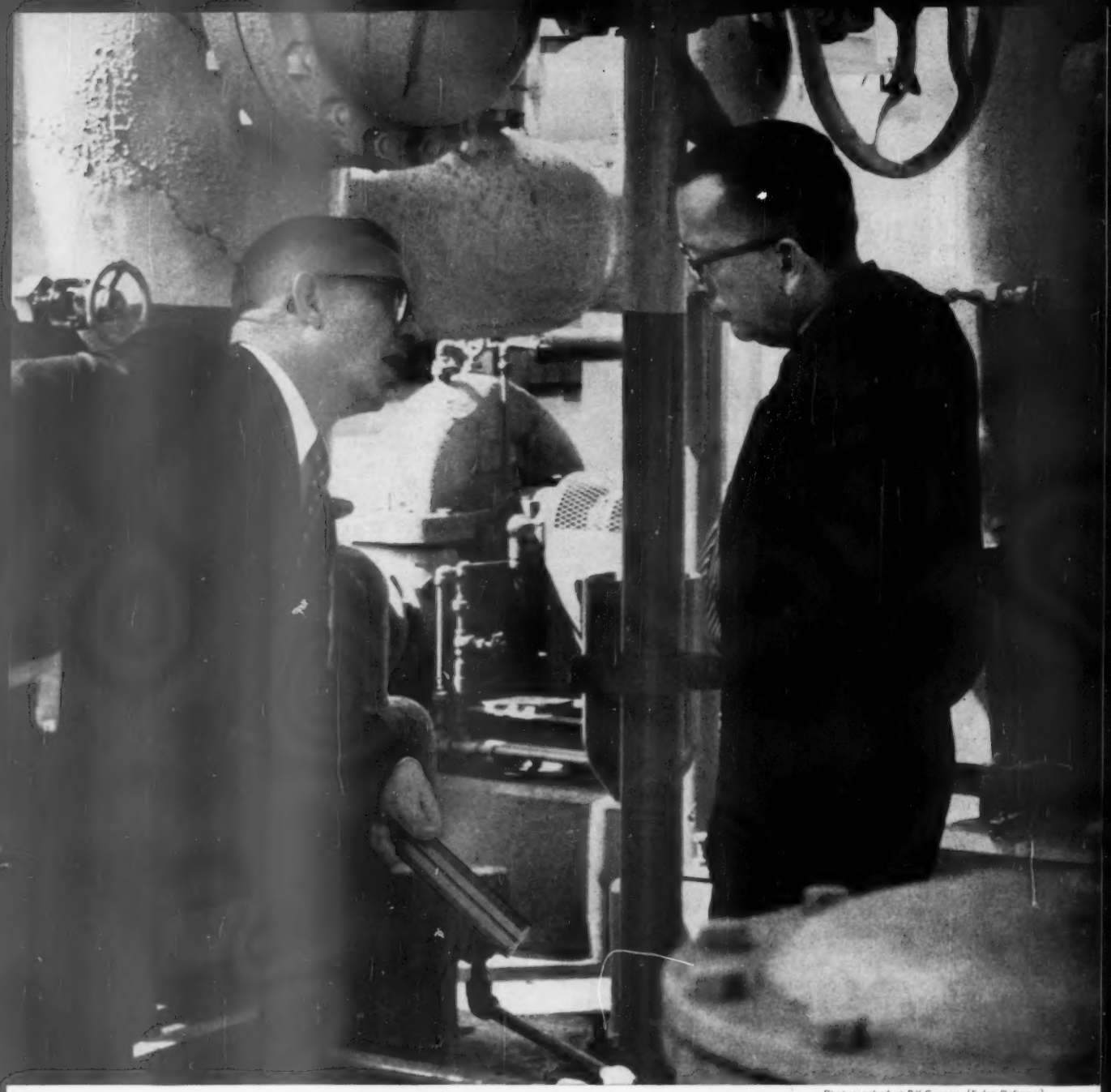

Photographed at DX Sunray, (Tulsa Refinery) .

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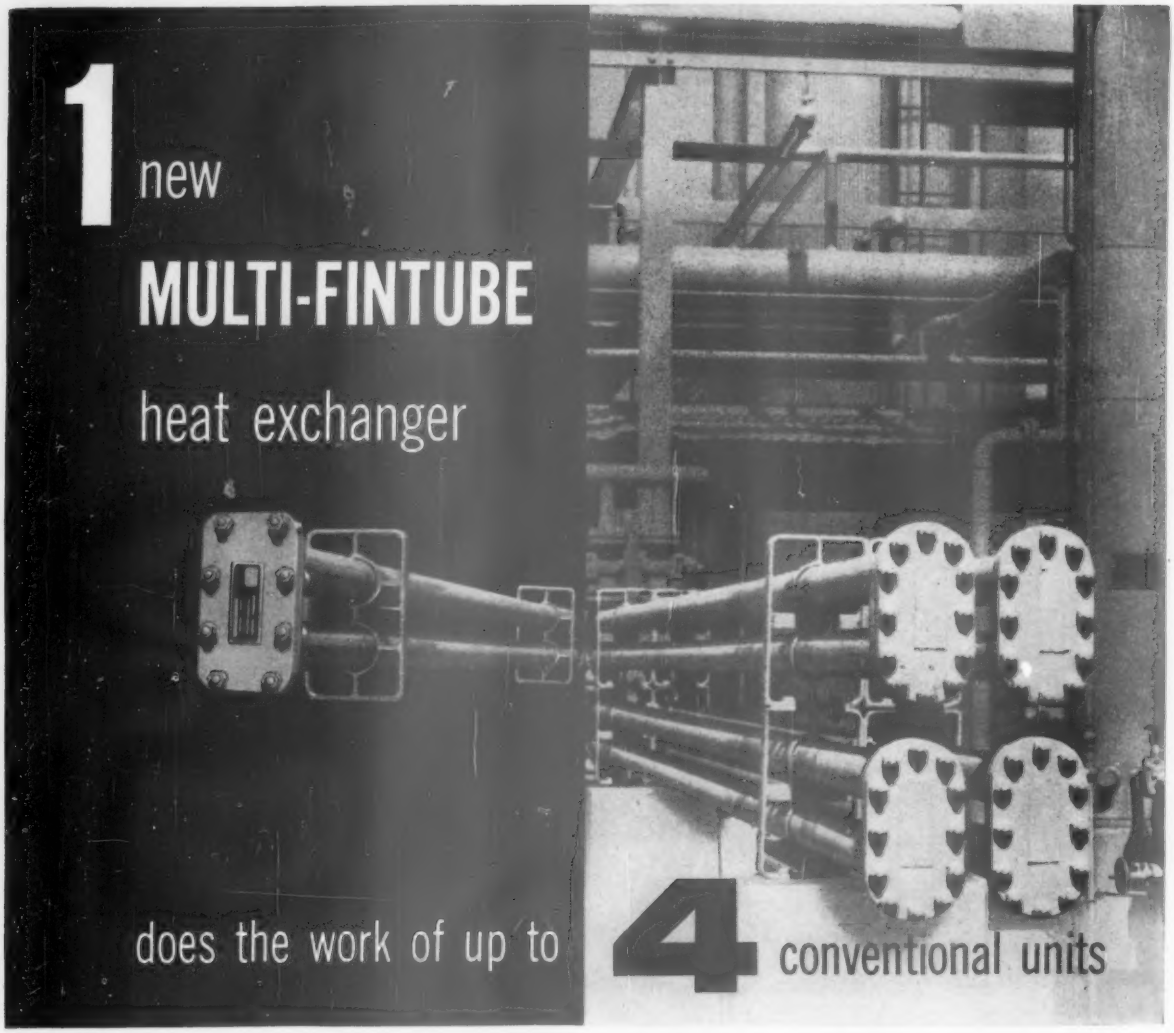

One new Brown multi-fintube heat exchanger has as much capacity as up to four conventional double pipe sections! Use of a bundle of finned tubes in each section ups heat transfer capacity substantially, permits standardized sections to be used for scores of additional duties, previously considered impractical or not economical. Further important cost savings are achieved by high fin efficiency factors, which makes this the ideal exchanger for light fluids such as light hydrocarbon products, chemicals and even water to water service! Obtain heat transfer savings of up to 50% or more. Investigate these cost-slashing units today.

Write for Bulletin 111 on Brown's new multi-fintube units. Address Dept. O-4, Brown Fintube Company, 300 Huron Street, Elyria, Ohio.

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Brown multi-fintube units permit true heat exchanger standardization. The proper quantity of the same identical unit may be used in banks to meet any given duty.

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- **LOW PARTS COSTS**—Only four parts for hundreds of exchangers.
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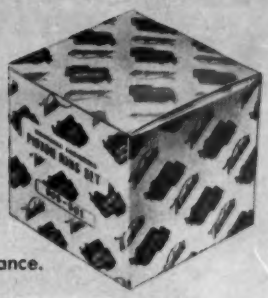

...in the original sealed packages—always obtainable from your Authorized Waukesha Distributor... are your best insurance of continuous satisfaction and economical engine performance.

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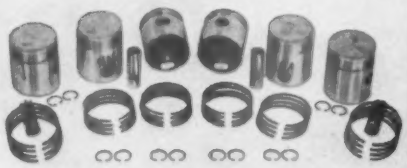

Matched in sets for weight and balance. Correctly fitted sizes.

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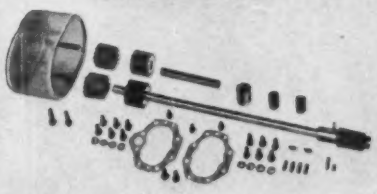

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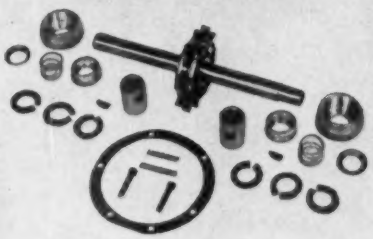

Precision bushings, shaft, seals—accurately balanced impellers.

> "There is hardly anything in the world that someone cannot make a little worse and sell a little cheaper—and the people who consider price alone are this man's lawful prey."
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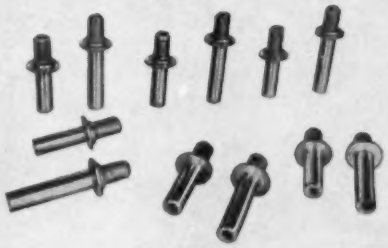

Service sized; inside and out—give just-right valve lubrication.

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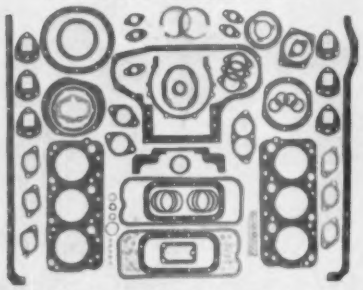

A right gasket for every place on your engine—dimensionally stable.

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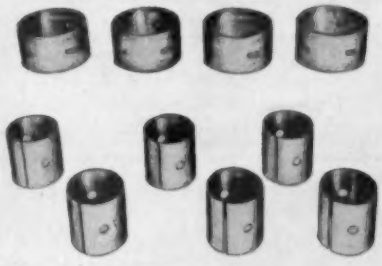

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SILICONE NEWS from Dow Corning

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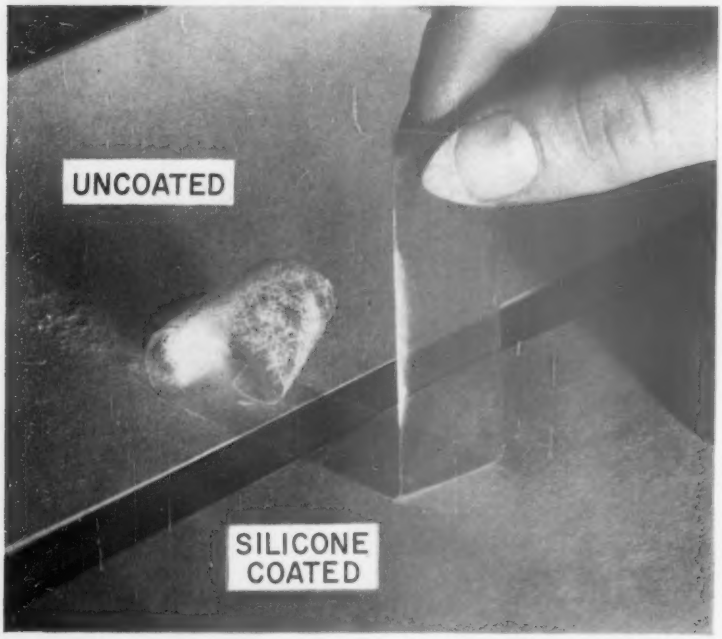

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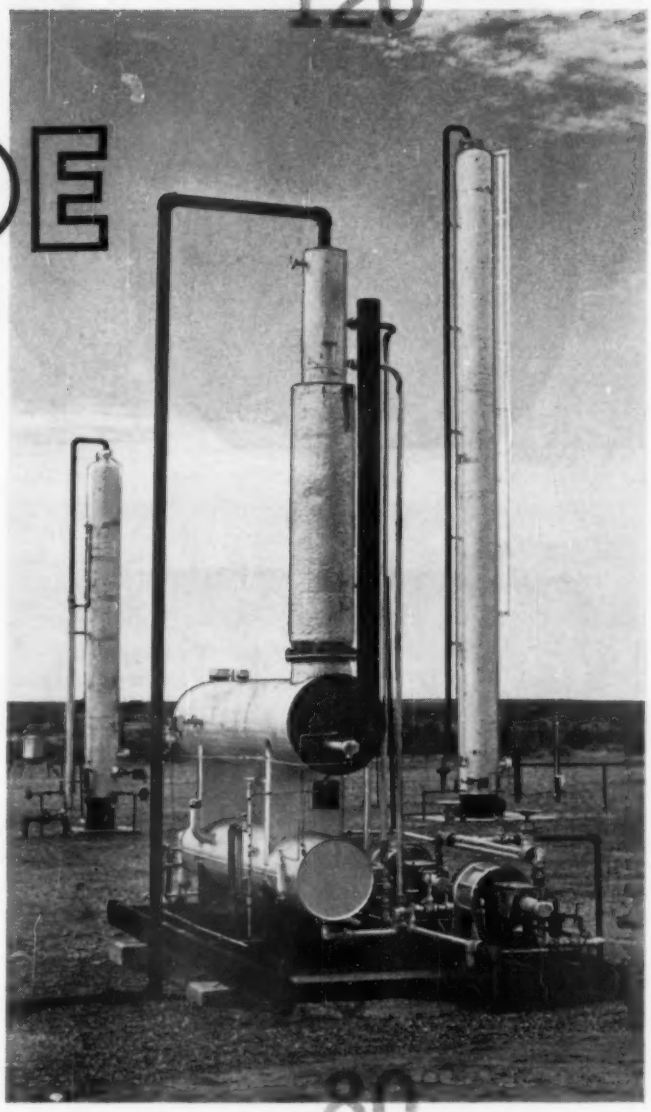
Your local BS&B sales representative will be glad to assist you in recommending the proper dehydrator for your gas streams. Write BS&B, Dept. 1-A4, Box 1714, Oklahoma City, Okla.



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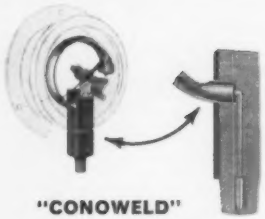

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Socket, tube—even end-piece—are actually fused into one piece by the Marsh "Conoweld" process. An instrument man described this integral socket and tube construction as the greatest recent advance in pressure gauge construction.

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Mastergauge has always been the standard of comparison, but we have never let that fact lessen our efforts to make it still better. A good example of this is the "Marshalloy" case illustrated above.

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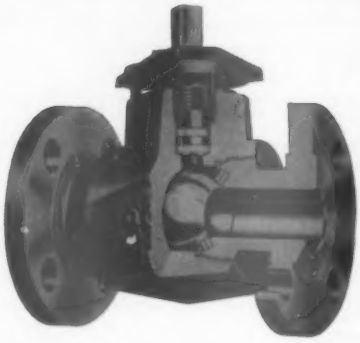
LEAKPROOF AFTER 600,000 CYCLES!



Proved in the laboratory, and in over five years of field service with such difficult ladings as acetone, propane, vinyl chloride, and lime and soda-ash slurry, W-K-M's ACF Ball Valve has earned a reputation for extra long life *without lubrication.* For example —

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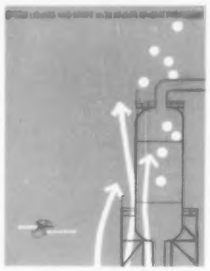

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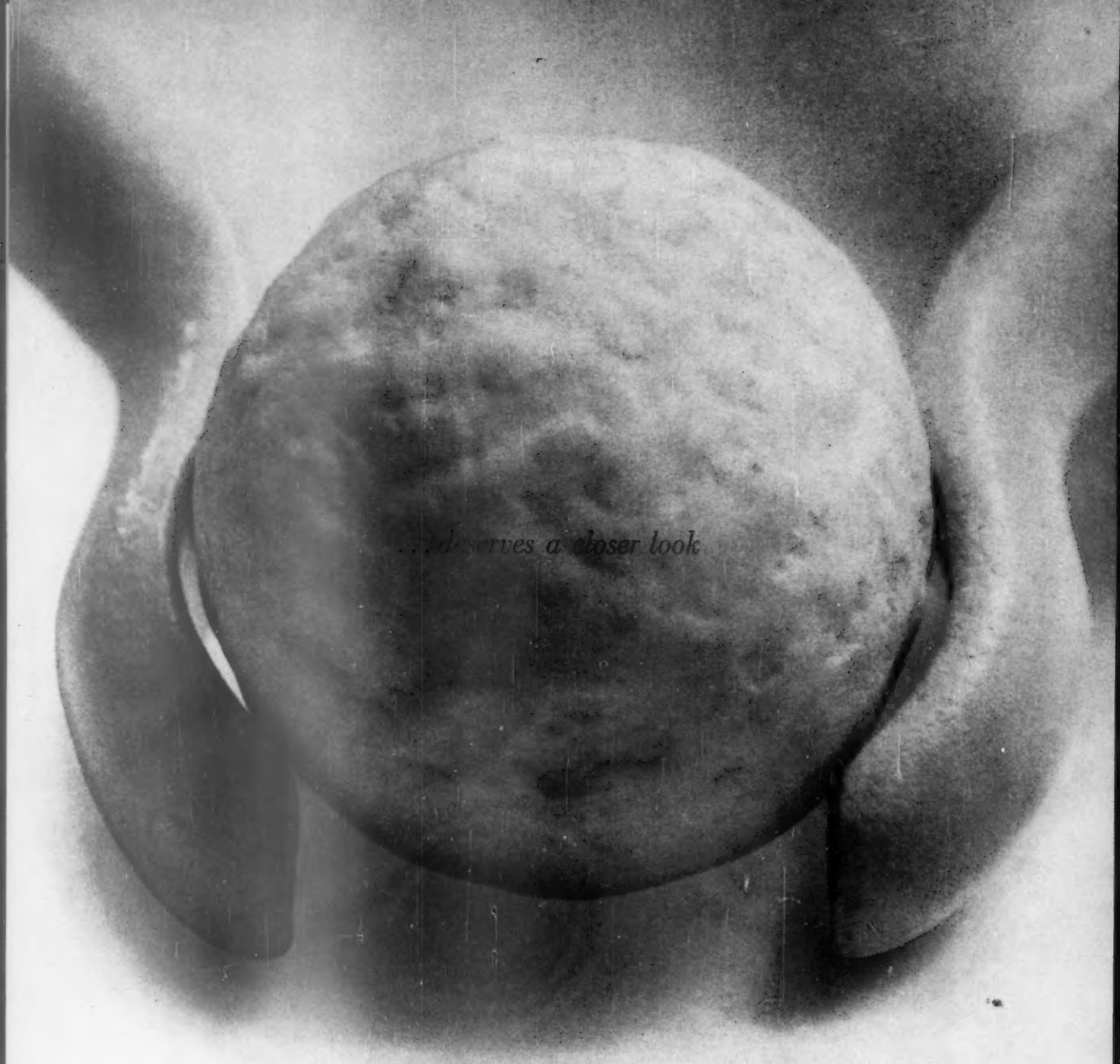

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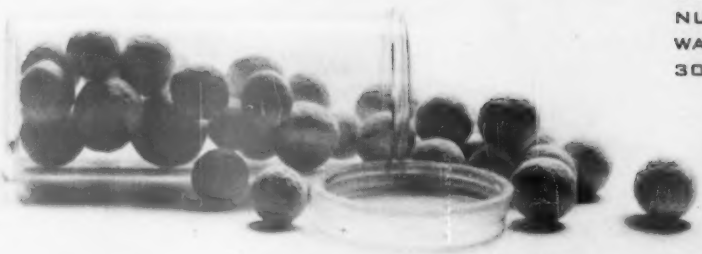

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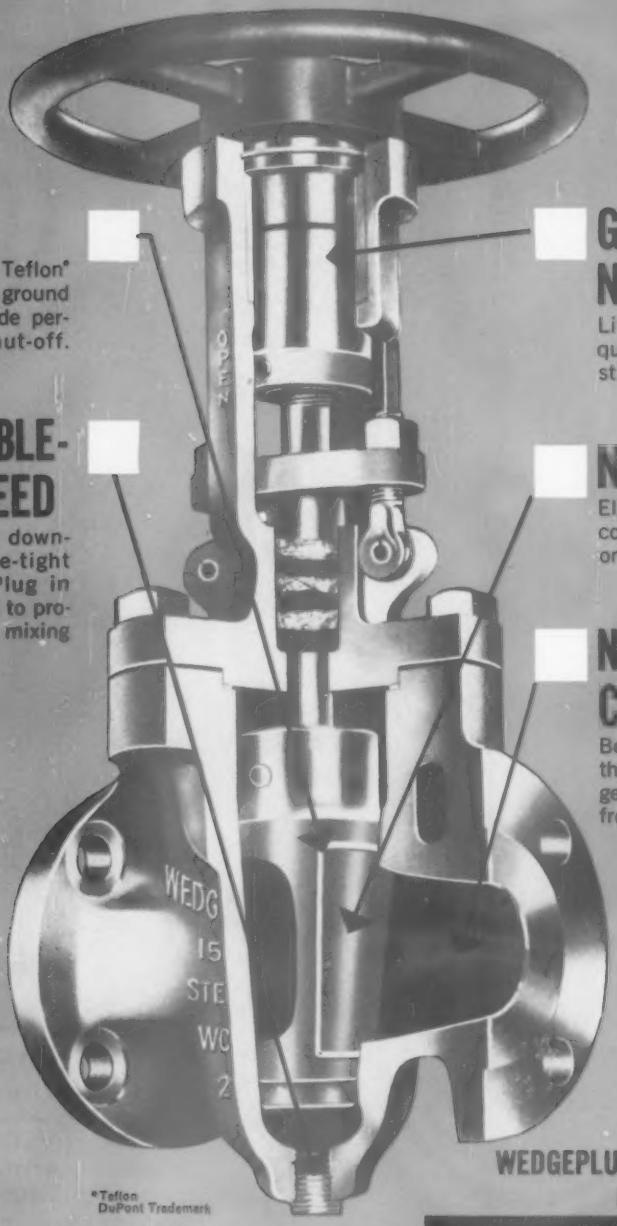
WITH STOCKHAM'S WEDGEPLUG O-SEAL VALVE



NO LEAKAGE

Pressure-sealing effect of Teflon* "O" rings in the plug plus ground metal-to-metal seats provide permanent bubble-tight shut-off. Safe in case of fire.

PROVIDES DOUBLE-BLOCK AND BLEED

Both the upstream and downstream seats hold bubble-tight against line pressure. Plug in bottom-boss can be pulled to provide bleed. Absolutely no mixing of products on manifolds.

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Lift-type plug engineered for quick, easy operation. Will not stick.

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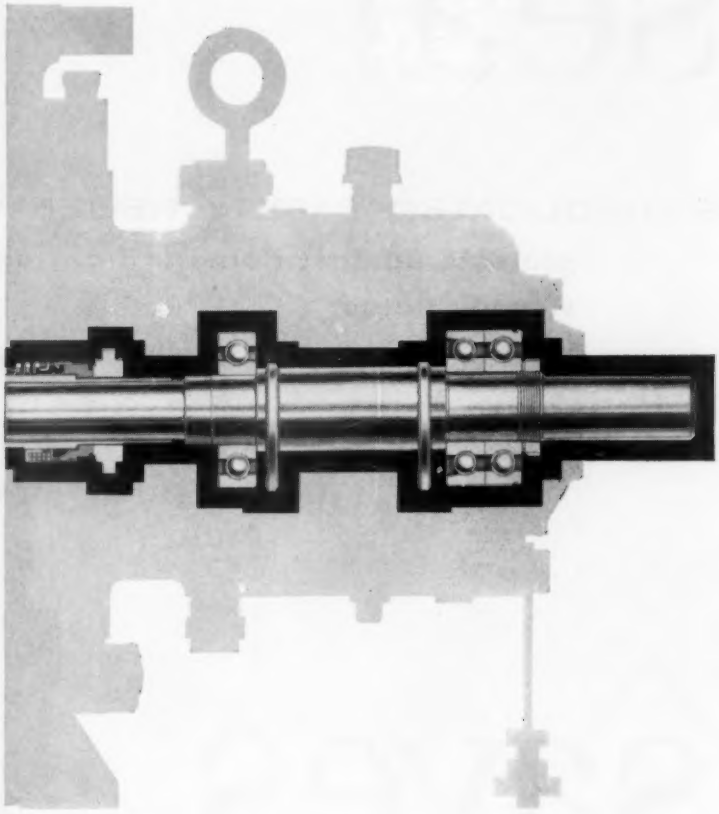
WHEN IT'S 750° HERE



. . . IT'S ONLY 250° HERE

intermediate-range pump HANDLES BIG, HOT JOBS

Now you can pump liquids *as hot as 750°F*—and handle pressures to 600 psi—with a pump that costs little more than a light-duty unit.

Goulds Model 3775 petroleum process pump can save you buying much heavier, costlier pumps for these jobs. It pumps 1200 gpm. And it is the only pump designed around a mechanical seal that gives you *both* high-temperature operation and easy upkeep of back pull-out.

Hot pumpage flowing through this pump never touches the mechanical seal—because the seal is isolated in its chamber and surrounded by cool, dead-ended liquid. Coolant circulates through jacket to hold seal face to 250°, even with pumpage at 750°. External flush or heat exchanger cooling is possible, too.

The seal is the *heart* of the pump, not an accessory. Because the pump is designed around the seal, it makes full use of seal advantages. Model 3775 has the lowest overhang ratio of any pump operating above 300°F. Its short shaft helps insure a true-running, long-lived seal.

Mechanically rugged, it is built to API 610 specs; centerline mounted with a vertically split casing. Typical of its quality is the dowel-pin fit alignment of bearing housing and casing cover, which assures perfect alignment and part replaceability.

To see where this cost-cutting pump can fit into your operations, send for our Bulletin 724-1. It gives specifications, construction details, pressure-temperature chart, and other helpful information.

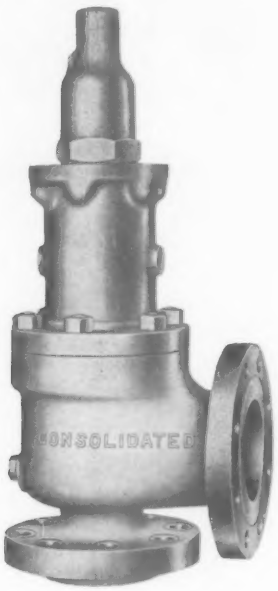
Goulds Pumps Inc., Dept. OGJ-41, Seneca Falls, N. Y.

GOULDS PUMPS

seal

CONSOLIDATED SAFETY RELIEF VALVE'S Sealing Bellows protects against damage from contaminants, corrosion, or viscous fluids

saves



Consolidated Safety Relief Valves are available in both Balanced Bellows and Standard designs. The Standard type has an eductor tube that effectively removes bonnet pressure.

Balanced Bellows Type Consolidated Safety Relief Valves have a durable, two-ply stainless steel Sealing Bellows that isolates and protects working parts from destructive elements in the lading fluid.

The bellows is balanced with the seating surface. Even with superimposed back pressure in the relieving system, valve performance is consistently stable and dependable. The bellows does not affect the high capacity of the valve, nor does it require change in set pressure. Even the blowdown adjustments are limited.

Additionally, Consolidated Safety Relief Valves now offer a no-leak tightness maintained by a resilient "O" Ring Seat Seal retained in the valve disc. This Seal assures tightness at operating pressures far closer to set pressure than with metal-to-metal seats alone, yet does not carry the seat load imposed by the spring. The Seal also takes piping strains much better than all-metal seating.

The Sealing Bellows and "O" Ring Seat Seal are typical of the extra quality built into Consolidated Safety Relief Valves to assure absolute protection for personnel and plant. These fine features plus flat seating and single ring construction also eliminate many maintenance problems and costs. Write for Catalog 1900 and Bulletin 1940.

MANNING MAXWELL & MOORE INC. MM&M TRADE MARK

CONSOLIDATED SAFETY RELIEF VALVES

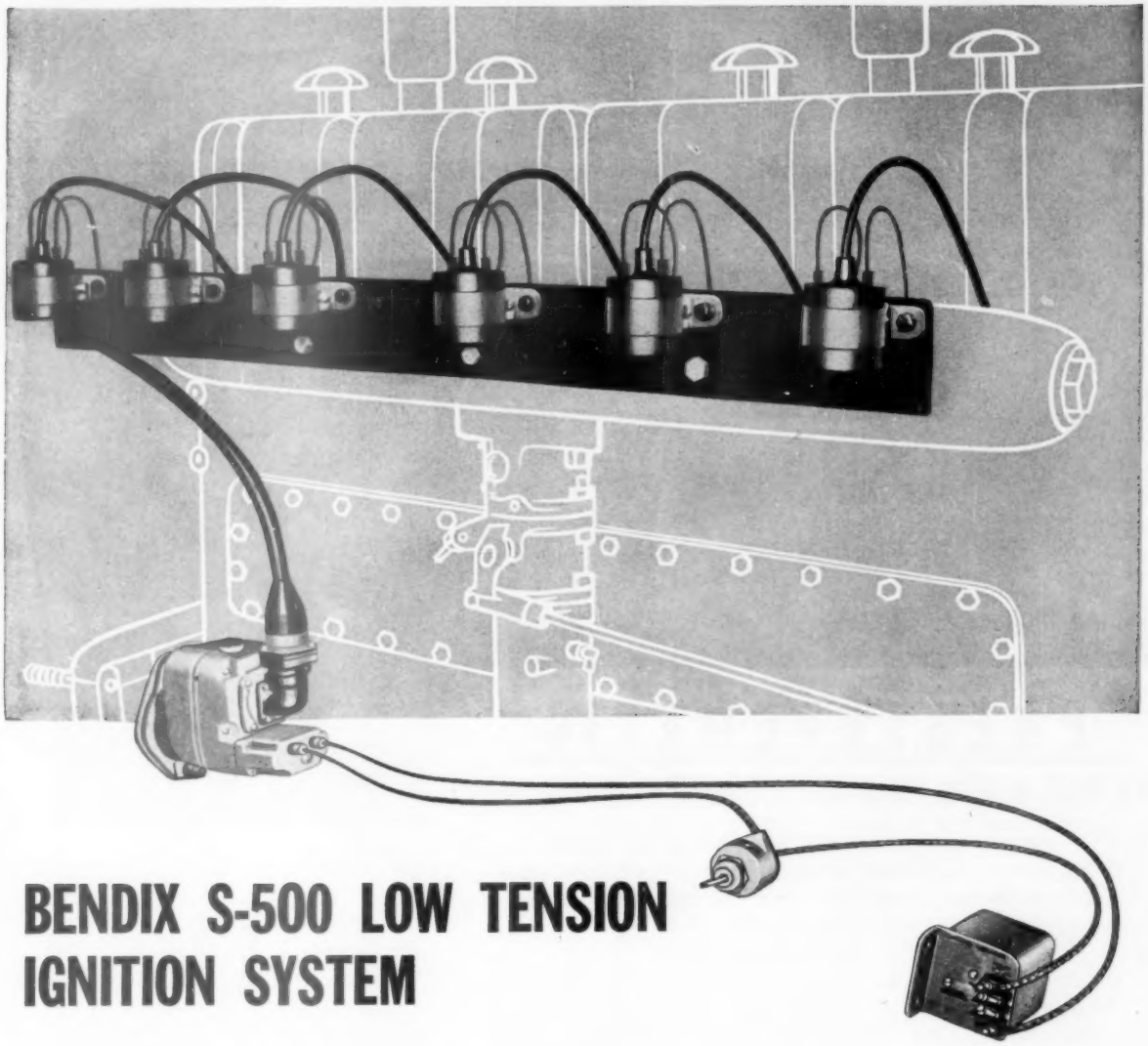
A product of

MANNING, MAXWELL & MOORE, INC.

Valve Division • Tulsa, Oklahoma

Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario
Latin America: Export Division, Chrysler Building, New York, N. Y.
Europe: Manning, Maxwell & Moore, S. A., Fribourg, Switzerland

The latest for small-to-medium industrial engines



BENDIX S-500 LOW TENSION IGNITION SYSTEM

The S-500 System provides the ultimate in starting and operating efficiency for your four, six, and eight cylinder industrial engines. Specify the new Bendix[T.M.] S-500 Low Tension Ignition System. It features "the modern starting concept"—retard breaker magneto and starting vibrator system.

This complete Low Tension Ignition System—including transformer coils, wiring cable assembly, starting vibrator, ignition and starting control switch, and retard breaker magneto—is custom-engineered to assure positive ignition at all cranking speeds and varied retard requirements. It is furnished in base or flange mounting, flameproof and radio shielded, is adaptable for manual or automatically controlled installations.

TRADEMARK

The S-500 Series, either base or flange mounted, is supplied with the following features:

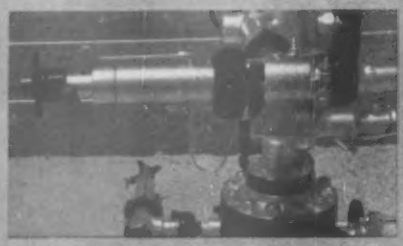
S-500 Standard Shielding, adjustable drive assembly.
S-501 Standard Shielding, adjustable impulse coupling.
S-502 Super-shielded, adjustable drive assembly.
S-503 Super-shielded, adjustable impulse coupling.
S-504 Standard Shielding, retard breaker, adjustable drive.
S-505 Super-shielded, retard breaker, adjustable drive.

For additional information concerning the best Bendix Ignition System for your particular engine requirements, write:

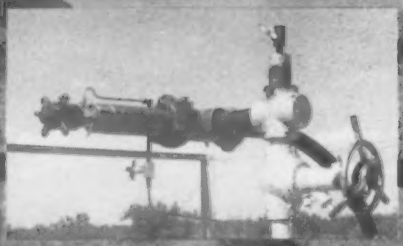
Scintilla Division
SIDNEY, NEW YORK

THE Bendix CORPORATION

Export Sales & Service: Bendix International, 205 E. 42nd St., New York 17, N. Y.



Reagan County, Texas
(Dual Completion).



Crawar Field,
Ward County, Texas.

Monument Field,
New Mexico.

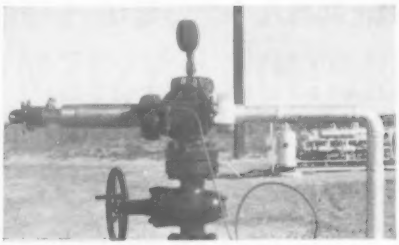
"PRESSUREMATIC"

it's both a wing valve and a high/low safety valve

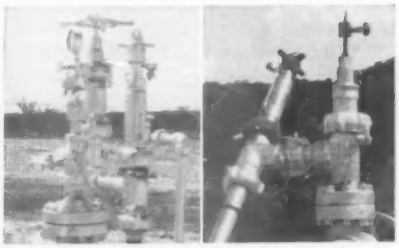
Here is a valve that does the work of two valves yet costs little, if any, more than a good high pressure valve alone. It operates manually for choke changing, or automatically as a high-low safety valve.

The **UNIBOLT PRESSUREMATIC VALVE** combines all of the time-tested and proven features of the Unibolt Adjustable Wing Valve with a novel automatic actuating accessory. The valve closes instantly when a pre-determined pressure balance across the seat is disturbed. The actuating mechanism consists of a small piston which is exposed to well pressure and a larger piston which is exposed to flowline pressure. A broken flowline or open valve, for example, in the production system, would lower the flowline pressure and thus instantly close the valve. Once closed, the valve may be easily opened and set manually for automatic operation. The downstream or low pressure line may be tapped at any remote point and thus embrace any desired portion of a gathering and treating system. Offshore and other remotely controlled wells could be shut in automatically in case of fire, ship collision, etc. The unique design lends itself to many such applications.

Send for literature or contact your nearest UNIBOLT sales representative.



Monument Field,
New Mexico.



Left—Lancaster Hill Field
(Ozona area, West Texas);

Right—Reeves County, Texas
(Dual Completion).

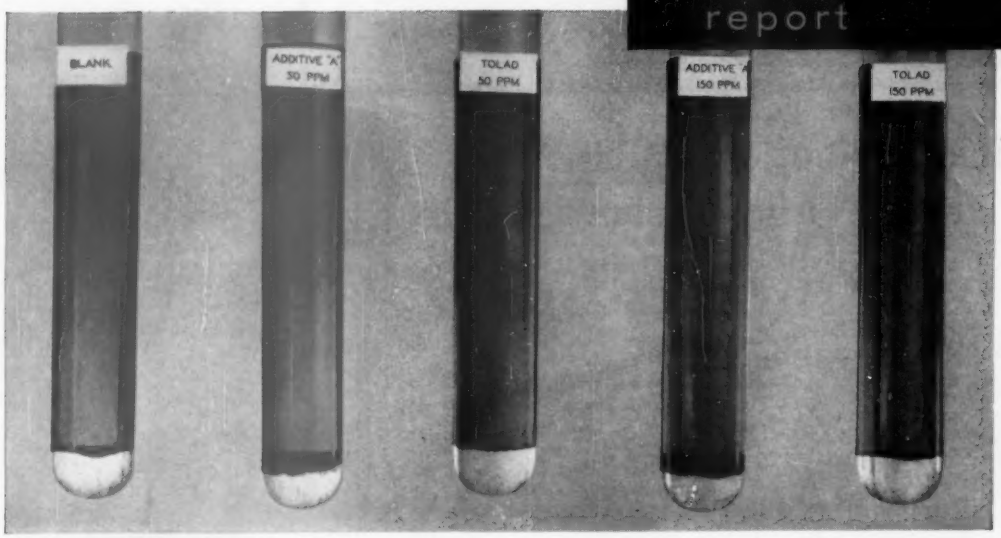
UNIBOLT

THORNHILL CRAVER CO.

P. O. Box 1184, Houston, Texas

another

TRETOLITE SERVICE report



TOLAD* *Fuel Additive maintains maximum water tolerance*

Compare the quantities of sludge in the test tubes. The TOLAD-treated fuel samples show much less sludge than the samples treated with a well-known competitive additive.

In the Tretolite Company research laboratories TOLAD Fuel Additives are continually compared with other commercial fuel additives. In test after test, fuels treated with TOLAD have had superior water tolerance.

WHY IS WATER TOLERANCE IMPORTANT?

When agitated, No. 2 fuel oils and diesel fuels form sludge if they contain water and insoluble residue. Some additives actually impair water tolerance.

HOW DO FUEL ADDITIVES AFFECT WATER TOLERANCE?

Additives which are primarily dispersants allow insoluble residue to form freely, but disperse it throughout the fuel. However, they also disperse any water which the fuel may contain, thus promoting emulsification, and eventually, sludge formation.

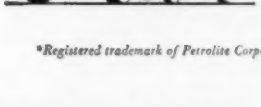
WHY DO TOLAD ADDITIVES MAINTAIN MAXIMUM WATER TOLERANCE?

TOLAD additives are primarily *inhibitors*. The normal water tolerance of the fuel is not impaired, and the residue problem is corrected by inhibition, rather than dispersion.

The use of TOLAD additives enhances marketability, and practically eliminates burner-tip fouling and filter plugging. In diesel fuel injection systems, TOLAD treatment prevents fouling, increases nozzle life.

In commercial application, TOLAD *has provided these advantages at costs under those of the additives it replaced.*

For information on TOLAD, or test arrangements for your fuel, write or call . . .



*Registered trademark of Petrolite Corporation

PETROLITE CORPORATION

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FA-60-3A

NATIONAL AIROIL BURNER

ENGINEERING NEWS

NATIONAL AIROIL BURNER CO., INC. • 1284 E. Sedgley Ave. • Philadelphia 34, Pa.

You may wish to check certain items in this advertisement and forward to those concerned in your company.

ROUTE TO:

_____

_____

_____

_____

National Airoil offers IMPROVED Model CP Vertical Firing Combustion Units

Here's big news! Now available is the *improved* National Airoil Model CP Vertical Oil Firing Combustion Units, ideally suited for use with stills, heaters, super-heaters, vaporizers, air-heaters, and other process furnaces in refineries, oil producing fields, and chemical plants. The units are used extensively in vertical and horizontal tube heaters of either cylindrical or box types. The units also are available for gas fuel and combination gas and oil.

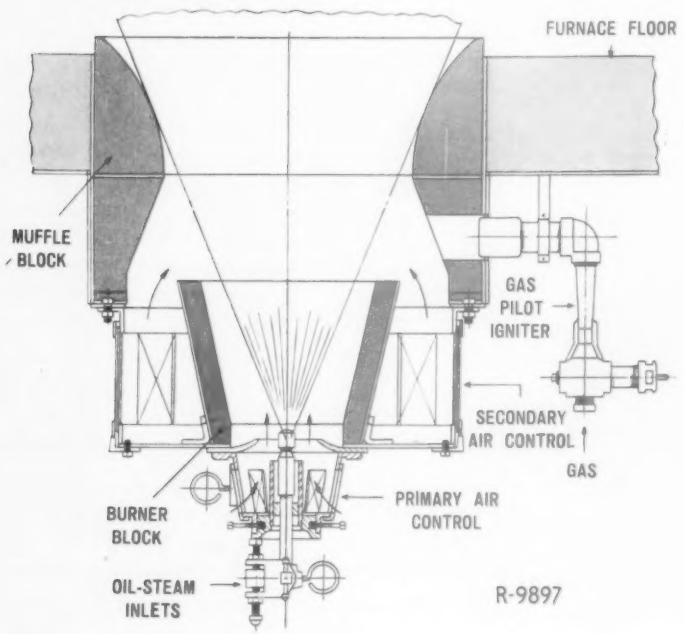
These modern CP oil units have added features that result in:

- **More stable fuel ignition.**
- **Higher economy of oil combustion with a minimum of excess air.**
- **Cleaner flames without dripping on heavy fuel oils.**
- **Flame patterns commensurate with furnace shape and arrangement of heat absorbing surfaces.**
- **Maximum radiation of heat from oil flame.**
- **Susceptibility to a varying demand of heat load.**

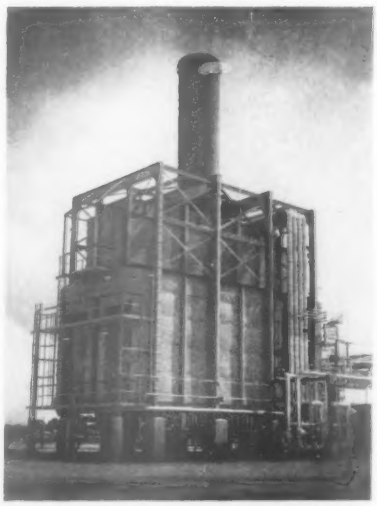
National Airoil CP oil units are available in six standard sizes that readily take care of the range of capacities most frequently specified. Two other special sizes are available for unusual conditions.

The units can be supplied to perform on natural or forced draft. On natural draft, they can be adapted to automatic combustion control, working the secondary air register. A different adjustment can regulate forced draft.

Where required, the CP units can be equipped with the dependable National Airoil Pilot-igniter Gas Burner for either continuous burning at 1% of the total heat load, or for intermittent operation as for ignition or start-up. Also, they can be furnished with the reliable National Airoil Electric Ignition System as used in chemical plants throughout the world.



Vertical cylindrical oil heaters perform more satisfactorily when operated with National Airoil CP Combustion Units.



National Airoil CP Combustion Units are ideal for use on horizontal tube, box furnaces like the one pictured here.

•

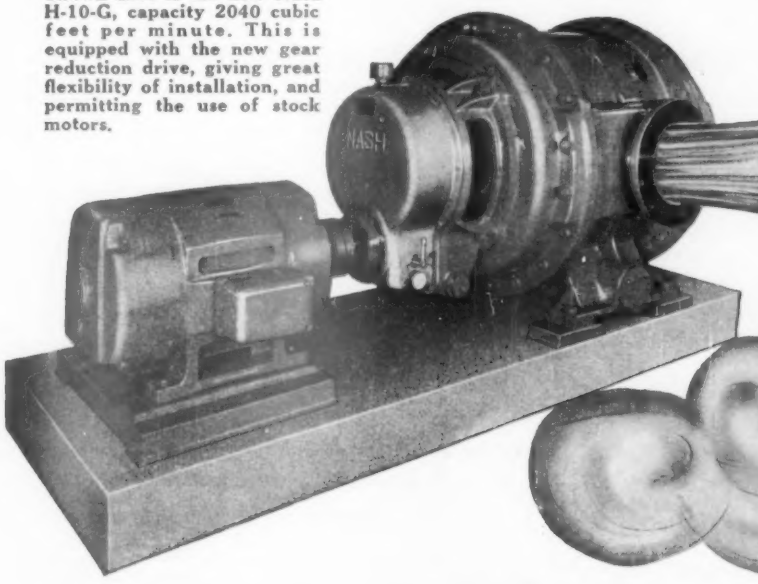
A National Airoil Representative will be happy to discuss how these improved CP combustion units will assure increased performance in your installation. Descriptive literature is available. Write today.

•

Nash Compressors Tame "Hard-to-handle" Corrosive Gases

The reasons for the success of Nash Compressors in handling "dirty" and corrosive gases are simple. First, Nash Compressors have no internal parts in wearing contact, or requiring close tolerances and internal lubrication. Second, because of the Nash operating principle, a variety of liquids can be employed as the compressant medium, protecting the interior from corrosive action. Third, the pump casing may be fabricated from a variety of special metals and alloys. That is why Nash Compressors take these rugged jobs in stride.

Nash Vacuum Pumps offer the same basic advantages when handling corrosive gases, and reliably maintain vacuums up to 29.50 inches of mercury.



Shown here is the new Nash H-10-G, capacity 2040 cubic feet per minute. This is equipped with the new gear reduction drive, giving great flexibility of installation, and permitting the use of stock motors.

ACETONE
ACETYLENE
AMMONIA
ARGON
BUTADIENE
CARBON DIOXIDE
CARBON MONOXIDE
CHLORINE
ETHYL CHLORIDE
FLUE GAS
FURFURAL
HEXANE
HELIUM
HYDROGEN
HYDROGEN SULPHIDE
NITROGEN
OXYGEN
PHOSPHOROUS PENTOXIDE
SULPHUR GAS
VINYL ACETATE
VINYL CHLORIDE
AND MANY OTHERS

NASH ENGINEERING COMPANY

SOUTH NORWALK, CONNECTICUT, U. S. A.

"Explosion-proof EXIT *signs!*

Where do you expect me to get them ?"

As you can see, they found the explosion-proof exit sign. It's Crouse-Hinds No. EVA139.

Look in your Crouse-Hinds catalog, of course. There's nearly everything you could want for hazardous areas listed there. Nine different types of explosion-proof telephones... horns, bells, clocks, pilot lights, instrument enclosures, gauge lights. Even X-Ray film illuminators. And, of course, modern designs in all the familiar explosion-proof motor controls, switches, plugs, receptacles, panel boards and lighting fixtures. UL-listed for every Class and Group in Article 500, National Electrical Code.

So, whether you're looking for conventional or out-of-the-ordinary explosion-proof electrical devices, contact Crouse-Hinds. If you design, buy or work with hazardous-area equipment, a Crouse-Hinds catalog should be on your desk. Ask your Crouse-Hinds Representative.

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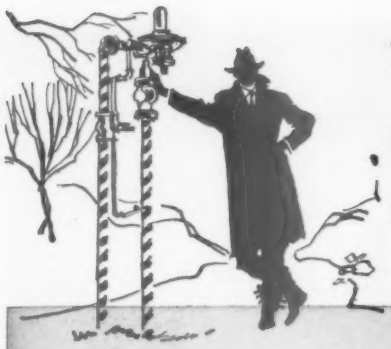
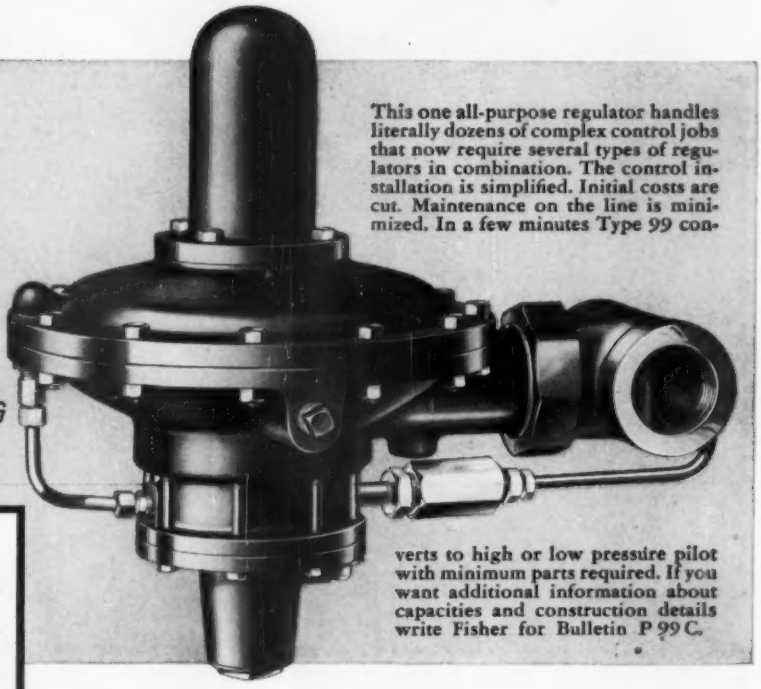


Your *FISHER/MAN* offers you a silent sentinel with hundreds of applications

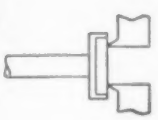
FISHER TYPE 99

MULTI-PURPOSE PRESSURE REDUCING GAS REGULATOR

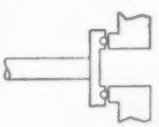


This one all-purpose regulator handles literally dozens of complex control jobs that now require several types of regulators in combination. The control installation is simplified. Initial costs are cut. Maintenance on the line is minimized. In a few minutes Type 99 converts to high or low pressure pilot with minimum parts required. If you want additional information about capacities and construction details write Fisher for Bulletin P 99C.

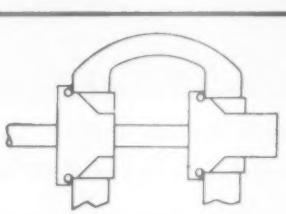
ORIFICE SIZES— INNER VALVE STYLES



⅞" Composition Disc Single Port. Max. Inlet 250 psi. 1½" Composition Disc Single Port. Max. Inlet 150 psi.

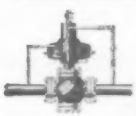


⅞" "O" Ring Single Port. Max. Differential 250 psi. 1⅛" "O" Ring Single Port. Max. Differential 250 psi. (with heavy main spring) 2" "O" Ring Single Port. Max. Differential 40 psi.



2" "O" Ring Double Port. Max. Differential 100 psi.

1. **The factory pre-set spring provides powerful lock-off action.**
2. **Large, effective area of main diaphragm in combination with relay pilot assures trouble-free accuracy.**
3. **It is only a matter of minutes and a minimum of parts to convert to high or low pressure pilot.**
4. **2" threaded or flanged inlet and outlet. Standard hi-tensile iron body for up to 150 PSI inlet, XH or bronze body for up to 250 PSI inlet.**
5. **Composition valve disc assures tight shutoff on zero flow and excellent regulation from low flow to maximum capacity.**



IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . .

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania

FISHER® Controls

SINCE 1880

The oilman paints a "dream" house – When the lady finally makes up her mind, she can be sure her choice is a good one. Solvents from petroleum will give her the paint job she wants, and keep her new home beautiful for years and years to come. Long-lasting finishes for home and industrial use represent another achievement of petroleum research – and another note of thanks the consumer owes to you, the oilman. If you hear someone criticizing oil, you've good reason to speak up in return. The thousands of products derived from petroleum are proof that you've helped to make it one of the world's most versatile natural resources.

SHELL OIL COMPANY

...used at a large SOUTHWESTERN PRODUCTS PIPELINE TERMINAL

The LimiTorque Operators shown above are of the integral control type—mounted on Plug Valves . . . The "packaged units" offer integral mounted NEMA rated reversing controllers, push-button elements, selector switches, all mounted inside the hinged cover for quick, easy accessibility. LimiTorque "Integral Control" Operators can save as high as 50% over separate component equipment and installation costs—and they are simple, foolproof and absolutely reliable. Many combinations of control elements are available. Send for Special Bulletin #10-A-58 which describes and illustrates these exclusive, rugged, trouble-free Valve Operators.

LimiTorque is by far the World's most widely used Motorized Valve Operator on oil and gas lines, and in refineries. There is no guesswork or labor connected with LimiTorque Valve Operator . . . one key man can open and close any type of valve quickly, dependably, and safely in remote or hazardous locations—and they can be easily field-mounted on existing valves . . . Contact your valve manufacturer or nearest LimiTorque Sales-Engineering Office.

THERE IS NO SUBSTITUTE FOR —
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INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS
Limitorque Corporation • King of Prussia, Penna.

CONTACTOR NUMBER 6

AMINE PROCESS DESIGN AND OPERATING INFORMATION

Proper use of amines in well designed, correctly operated equipment is essential for efficient gas treating. Some of these important design and operating considerations will be discussed in this series.

Foaming Difficulties in Treating Systems

Foaming difficulties are frequently encountered in the operation of gas treating units employing Ethanolamines and Ethylene Glycols. The mere production of some foam is not necessarily a sign of trouble. But if the foam generated is too stable, you can expect difficulties in operating gas treating columns.

Analyzing Foaming Characteristics

The foaming characteristics of a solution may be determined qualitatively by using a medium or fine fritted glass dispersion tube to bubble air through a sample of the plant solution in a graduated cylinder. You should have a means of measuring air flow so that reproducible rates can be used. Use two or three air flow rates – e.g., .03, .05 and .10 cu. ft./min. for a 50 ml sample. Make observations at room temperature and at about 50°C (122°F) for the following:

1. Type of foam formed (bubble size, apparent consistency).

2. Time required for foam to reach maximum height.

3. Time required for foam to break after air flow is stopped.

Evaluate these observations by running the same test on equivalent amine or glycol solutions made up from fresh, unused amine or glycol.

Common Foam Stabilizers

Excessive foaming is usually caused by small amounts of stabilizers. Known offenders are:

- Field corrosion inhibitors carried into the units from the field.
- Plug valve greases which contain soap bases.
- Napthenic acids and higher molecular weight organic acids which are present in certain petroleum streams.
- Suspended solids.
- Hydrocarbons dispersed in the solution.

Proper Care Best Cure

The best cure for foaming problems is proper care of the amine or glycol solution. In amine systems, first preventive steps are proper reclaimer operation and adequate filtration—using activated charcoal, in some cases, to adsorb foam-generating materials. In glycol systems, first steps are proper pH control, adequate filtration and provision for good separation of hydrocarbons and glycols.

If foam inhibitors are needed, it should be remembered that these do not solve the basic problem, but merely provide control until the cause can be determined and remedies effected.

Effect of Additive on Foam

The effect an additive has on foaming properties of a system frequently depends on when it is added. Hence, some materials—if added after foam is generated—act as foam inhibitors, but—if added prior to foam generation—act as foam stabilizers. This is important in evaluating foam suppressants.

Evaluating Foam Inhibitors

Foam inhibitors should be evaluated on a laboratory scale by adding them to a sample prior to running the foam test described above. Since the effectiveness of a defoamer depends on the chemical nature of the materials causing the foam, each unit has to be evaluated individually with various inhibitors.

Of compounds with defoaming properties, oleyl alcohol has been widely used in amine systems as a defoamer. It is also effective in glycols. However, in glycol systems, it is more effective in combinations with C_{10}-C_{12} alcohols. These alcohols work best against non-ionic foaming agents.

Silicones are effective against certain ionic foamers such as sulfonated petroleum oils. Combinations of silicones, too, in some cases, suppress foam better than one alone.

In testing foam inhibitors, look for ease of dispersion. This will give you a clue to a defoamer's duration of activity since inhibitors which are difficult to disperse may be readily lost from the system.

FOR MORE INFORMATION look for future issues of Allied Chemical Contactor featuring articles on Ethanolamines and Glycols in gas treating operations.

We will gladly send technical data, delivery and price information on Allied Chemical Ethanolamines and Ethylene Glycols.

For specifications and local offices, see our insert in Chemical Materials Catalog, page 272 and in Chemical Week Buyers Guide, page 27A.

BASIC TO AMERICA'S PROGRESS

2819

Allied Chemical

NITROGEN DIVISION

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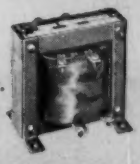
SQUARE D SPIN TOP® ENCLOSURE NOW MORE VERSATILE THAN EVER!

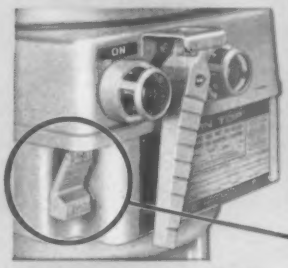
DAMAGE-RESISTING Acme threads. If you've struggled with "banged-up" threads, you'll appreciate this feature. It's always a breeze to put on and take off tanks for installation, inspection or maintenance.

FULL WEATHER PROTECTION - Male threads on collar engage female threads on tank—no external threads to be damaged.

NEW! ***CONTROL TRANSFORMER*** can be mounted in collar. No special-length tanks required.

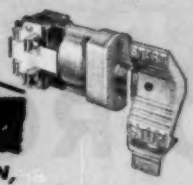


INCREASED WIRING SPACE - Four conduit openings standard, with through-feed conduit entrances for horizontal tap-offs optional.

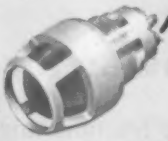


NEW! ***SELECTOR SWITCH*** is made in one piece, installs simply by threading into opening provided in enclosure. One-piece construction permits pre-testing before shipment.

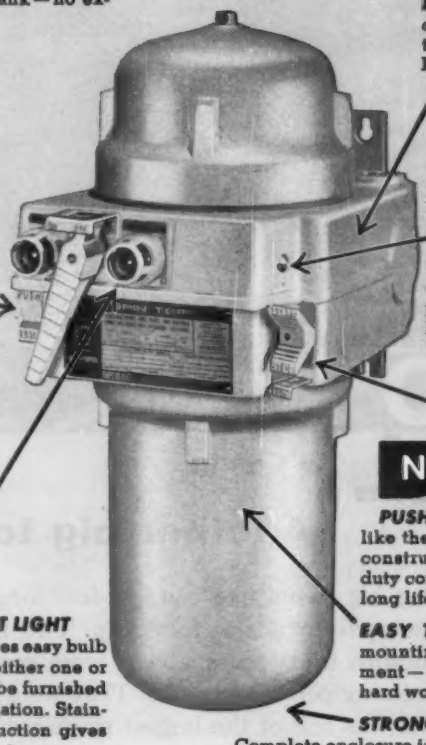
NEW! ***RECESSED CONTROL STATIONS*** like the reset button are out of the way, have no protrusion to break or bend accidentally.



NEW! ***PUSHBUTTON,*** like the selector switch, features one-piece construction for easy installation. Heavy-duty contacts and rugged mechanism assure long life.



NEW! ***BRILLIANT PILOT LIGHT*** is visible from all angles and provides easy bulb change. Enclosure available with either one or two factory-mounted lights or can be furnished with plugged holes for field installation. Stainless steel thread-in-thread construction gives corrosion-resistance and easy servicing.



EASY TO INSTALL with *slide and hook* mounting arrangement for interior equipment—a Square D "exclusive." Takes the hard work out of the installation job.

STRONG AND LIGHTWEIGHT construction. Complete enclosure is cast aluminum. All operating shafts are stainless steel, thread-in-thread, for the best in corrosion resistance.

Square D *is Better in So Many Ways!*

When you buy from Square D, you not only get all the benefits shown above—you also are buying from the only manufacturer who builds both the enclosure and the starter, giving you unit responsibility. Moreover, Square D offers better stocks, better on-the-spot service. That's why it makes sense to insist on Square D Spin Top enclosures for your hazardous location applications.

4 ENCLOSURE SIZES ACCOMMODATE NEMA SIZES 0 THROUGH 5

Square D Spin Top enclosures are NEMA 3 (weatherproof), NEMA 4 (watertight), NEMA 7 (explosion-proof) and NEMA 9 (hazardous locations) for Class I, Group C and D; and Class II, Groups E, F and G service.

Write for Bulletin 9990. Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin

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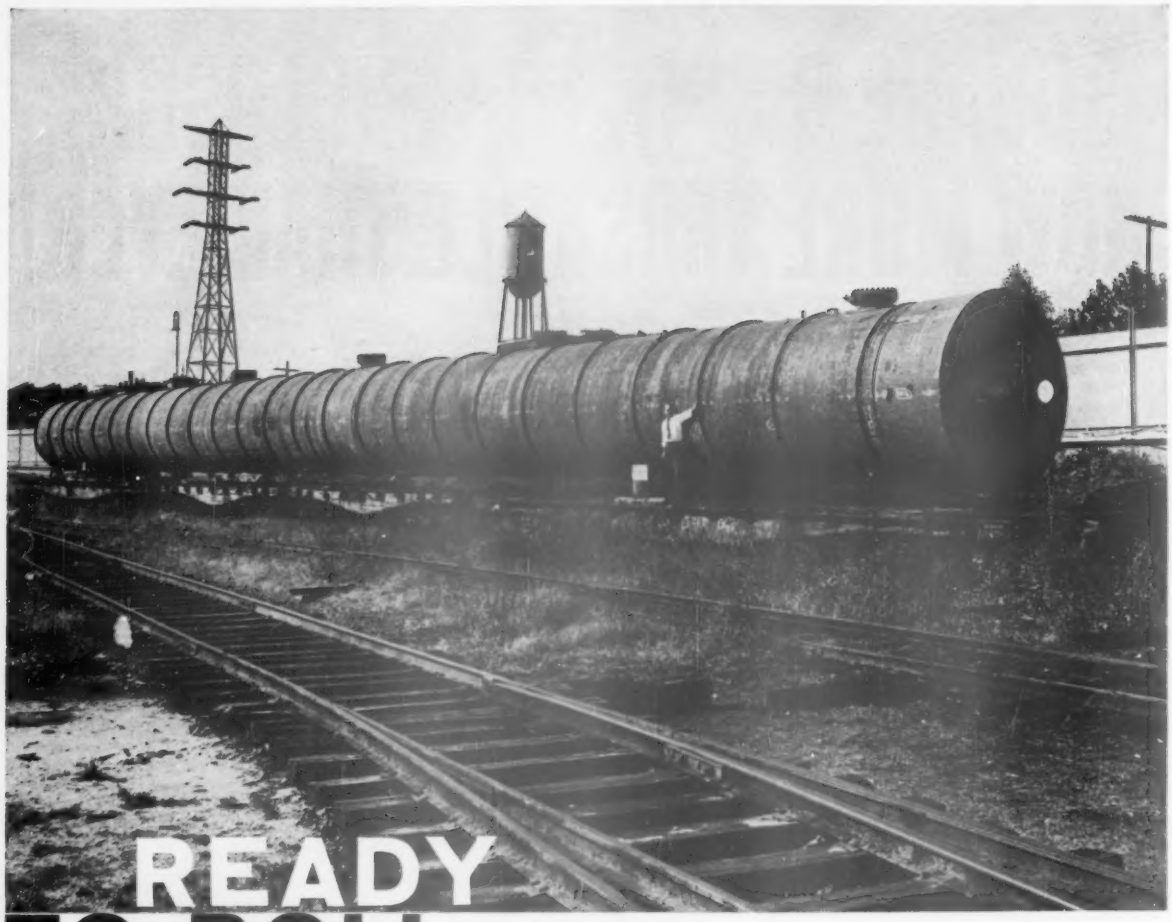
wherever electricity is distributed and controlled



READY TO ROLL . . .

Another big tower for industry

Building and delivering big items like the 165-foot-long fractionating tower pictured here is routine performance at Sun Ship. Two towers, each weighing 135 tons and identical with that shown above, were constructed for a petrochemical plant for processing petroleum gases. They were shipped on 9 flatcars. Railroad officials said it was one of the largest shipments ever moved by rail. Because of its length the shipment had to travel a circuitous rail route.

Whether it's a massive fractionating tower or intricate equipment, your requirements will be met with exacting precision and your product delivered on schedule by rail or water from our tidewater plant.

Sun Ship's modern fabricating and engineering services put these advantages at your fingertips. For full information, call or write our Sales Engineering Department.

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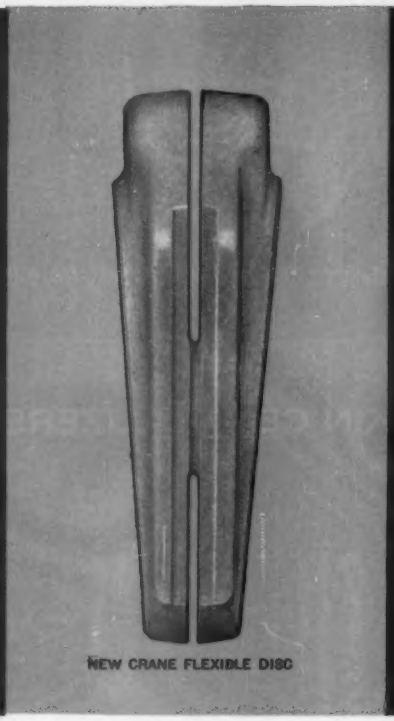
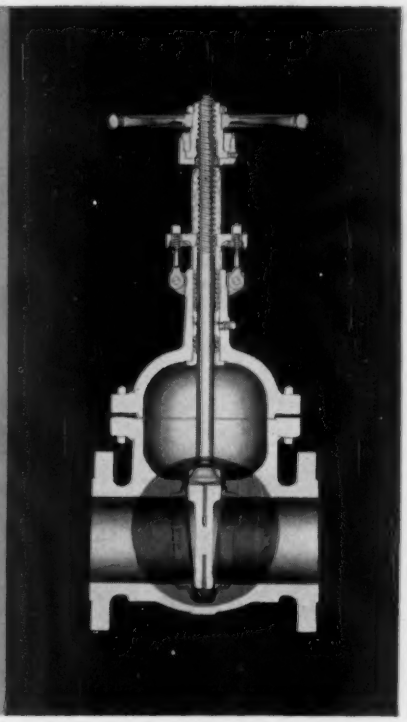
ANOTHER ACHIEVEMENT IN MODERN FLOW CONTROL BY CRANE



NEW CRANE FLEXIBLE DISC



Biggest gate valve advance in 25 years

CRANE FLEX GATES

Instead of being made with a solid disc, new, patented Crane Flex Gates have separate disc faces, connected by the axle-like unit shown in the cross section. This joins the two seating faces, yet provides flexibility for the faces to seat tightly with independent action.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates seat with less torque.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates unseat with less torque... will not stick closed even when closed while hot and allowed to cool.

BECAUSE THEY'RE FLEXIBLE, minor deflection of seating faces due to pipe strains does not affect tightness of Crane Flex Gates.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates are tight on inlet seat and outlet seat over a wide range of pressures.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates can be used singly in some services where two conventional gate valves are frequently specified. You can save substantially on piping costs.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates can be serviced—body seat rings replaced or seating faces refinished—quickly, and without painstaking accuracy. Slightly off-taper seats do not affect tightness or operating ease.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates will easily outperform any conventional solid wedge disc valve you now use. *And there's no increase in price.*

BECAUSE THEY'RE MADE BY CRANE, these new Flex Gates are completely dependable. You can use them with complete confidence on steam, water, gas, oil or oil vapor service. Stem and disc seating faces are Crane Exelloy. Shoulder-type body seat rings are Exelloy or Crane No. 49 Nickel Alloy. Sizes: 12 inch and smaller; 150- and 300-pound pressure classes.

Ask your Crane Distributor for full information on Flex Gates—and for data whenever you work with the products Crane makes. He has the newest in information and products. Crane Co., Industrial Products Group, 4100 South Kedzie Avenue, Chicago 32, Illinois.

CRANE

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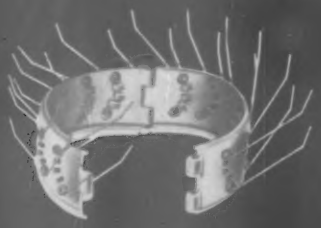
THE NEW LARKIN SCRATCHER . . .



combines all the outstanding features proved best for effective performance

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which exceed all known requirements for centralizer performance

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A complete line of

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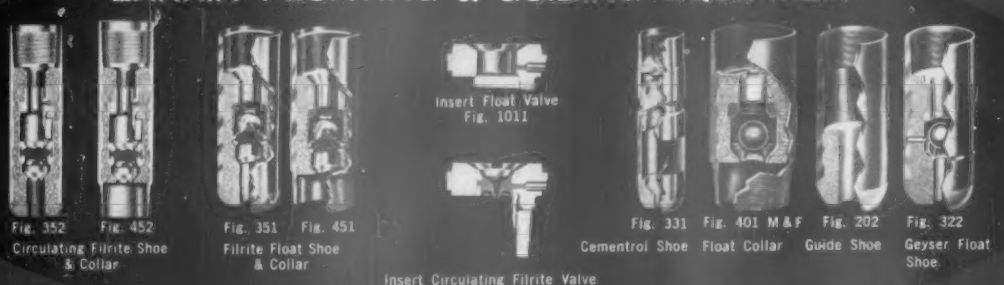

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How Much Steam Should a Steam Trap Trap?

. . . some answers to commonly asked questions about the primary job of a steam trap

You don't need a doctor's degree in thermodynamics to answer the question at the top of this page. Naturally, a steam trap should trap *all* the steam.

Unfortunately for you, the problem isn't quite that simple. After all, a shut off valve would trap all the steam . . . and condensate, and air, and carbon dioxide as well.

So we'd better amend the answer to the question this way: A steam trap should trap *all* the steam but *must* remove condensate, air and carbon dioxide as rapidly as they accumulate.

With this established, let's take a closer look at what's involved:

A Steam Trap Should Trap All The Steam

If you've had experience with several different makes of traps, you already know that some trap steam better than others. The operating principle of the trap is what makes the difference. We like to talk about it because Armstrong traps are designed so that no steam can get to the orifice. The valve is always water sealed. Result: *More efficient steam utilization, lower fuel costs.*

A Steam Trap Should Remove Condensate

All traps remove condensate—after a fashion. For maximum efficiency in the unit being drained, though, the trick is to get it out without waiting for it to cool and without leaking steam.

Armstrong's water sealed valve takes care of steam leakage. The inverted bucket operating principle opens the trap for water regardless of its temperature. This means you get the condensate out as quickly as it accumulates. Result: *Higher temperatures and better heat transfer in steam heated units.*

A Steam Trap Should Remove Air and CO_2

Part and parcel of the condensate removal problem is removal of air as well as oxygen and carbon dioxide—two real troublemakers. Air tends to reduce operating temperatures and interfere with heat transfer. CO_2 goes into solution to form corrosive carbonic acid which, for example, can eat unit heater tubes. O_2 aggravates the situation. Believe it or not, but all traps don't properly remove air and CO_2.

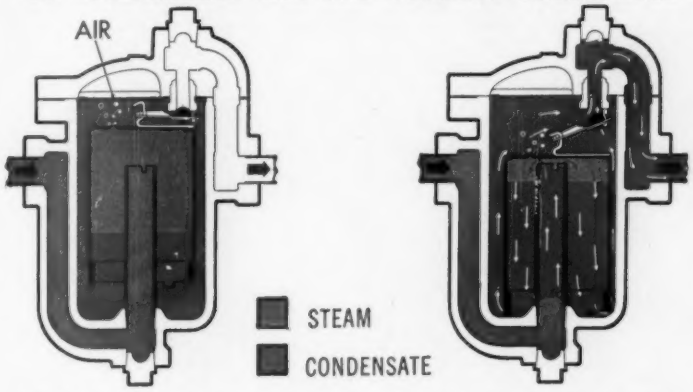
By now, you've probably guessed that Armstrong traps *do* remove air and CO_2. Armstrong design (see illustration) provides continuous venting of air and CO_2. By opening suddenly, the Armstrong trap creates a momentary pressure drop to "pump" the air down to be vented. Result: *Higher temperatures, faster heat-up, better heat transfer and reduced corrosion.*

Note: When required, specially sized air vents are furnished. For fast heat-up of low pressure on-and-off units, Armstrong provides open float and thermostatic air vent traps.

What's the Final Answer?

Summing it all up, you'll get the best service from steam heated units that are equipped with traps designed to trap *all* the steam and remove air and condensate as quickly as it accumulates. In our prejudiced viewpoint, this means Armstrong traps. More important are the several thousand users of Armstrong traps who have proved the point. See our catalog in "Refining Catalog"

HERE'S THE STEAM TRAP DESIGN THAT GETS RID OF CONDENSATE AND AIR WITHOUT STEAM LOSS



Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Before you make up your mind, though, consider the minimum maintenance requirements of Armstrong traps . . . and the convenient assistance your local Armstrong Representative provides. These are important plus values.

Put Up or Shut Up

We're so confident that we "put up". Armstrong traps are unconditionally guaranteed to satisfy. So you can find out for yourself with practically no risk. If you're not completely satisfied with the way they do their job, you can get your money back.

* * *

The 44-page Armstrong Steam Trap book goes into greater detail on these and other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write

Armstrong Machine Works
8681 Maple St. Three Rivers, Michigan

ARMSTRONG STEAM TRAPS
813-ST

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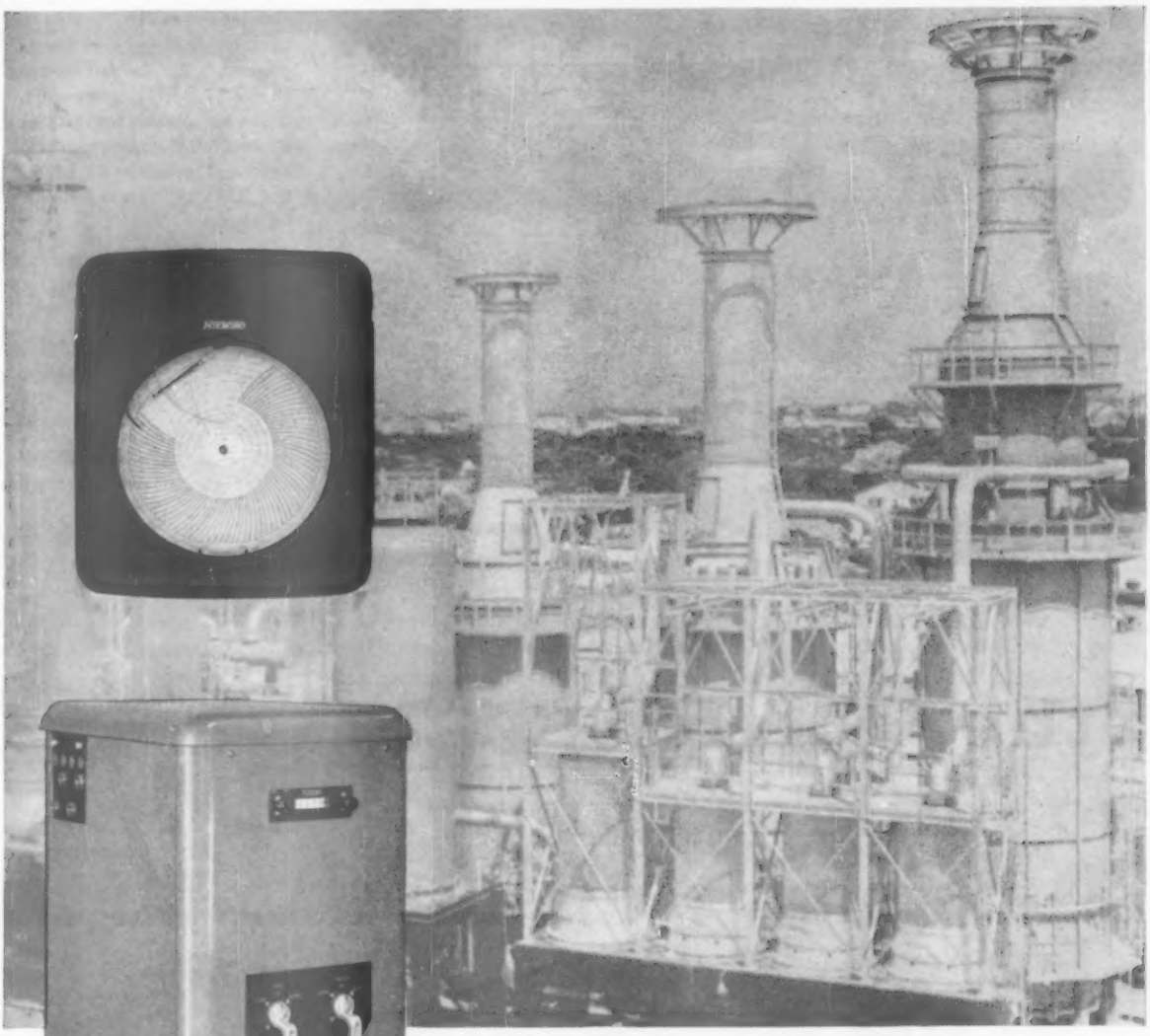

Top: Foxboro Capacitance Dynalog Electronic Recorder

Below: Foxboro Octane Improvement Analyzer

The Foxboro Octane Improvement Analyzer is based on a development of the Humble Oil & Refining Company. The Foxboro Company is licensed to manufacture the analyzer under patent rights held by Esso Research and Engineering Company.

this Foxboro system lets you measure octane improvement... continuously, automatically

Now you can have a continuous, accurate, automatic reading of octane improvement on any catalytic reformer equipped with the Foxboro Octane Improvement Analyzer.

Here's how it works. The field-located Analyzer alternately monitors the dielectric constant of the feed stream to — and the product stream from — a catalytic reformer. Both measurements are recorded directly on a Foxboro Capacitance Dynalog* Recorder. And, since a direct correlation exists between dielectric constant difference and octane improvement, the Dynalog chart provides a continuous record of octane improvement.

The Foxboro Octane Improvement Analyzer pays for itself in as little as six months by providing data for faster recovery from reformer upsets. It also substantially reduces the number of knock-engine analyses required. Ask your Foxboro Field Engineer about this unique refining aid. Or write for Technical Information 27-111a. It has all the details. The Foxboro Company, 604 Neponset Avenue, Foxboro, Mass.

Reg. U. S. Pat. Off.

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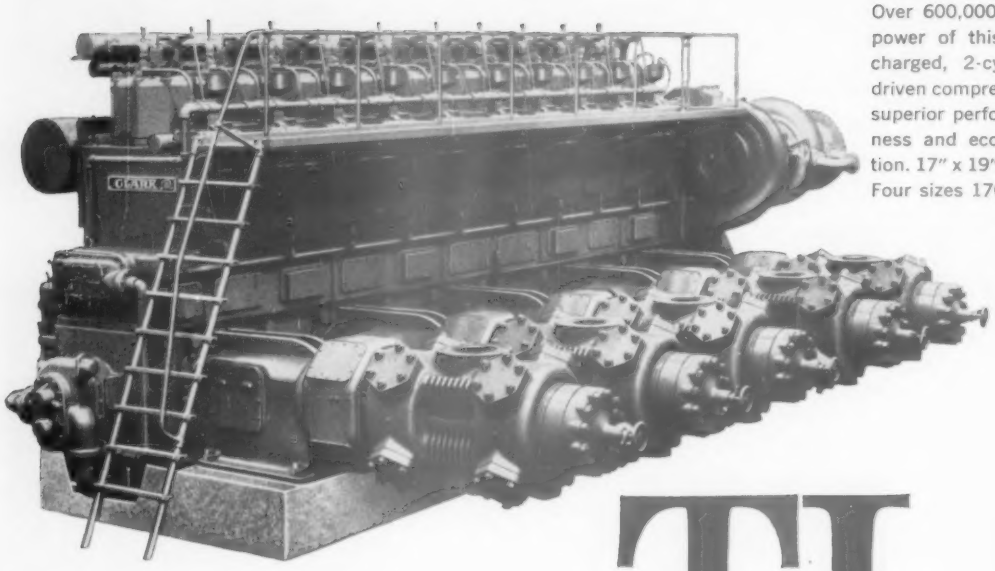
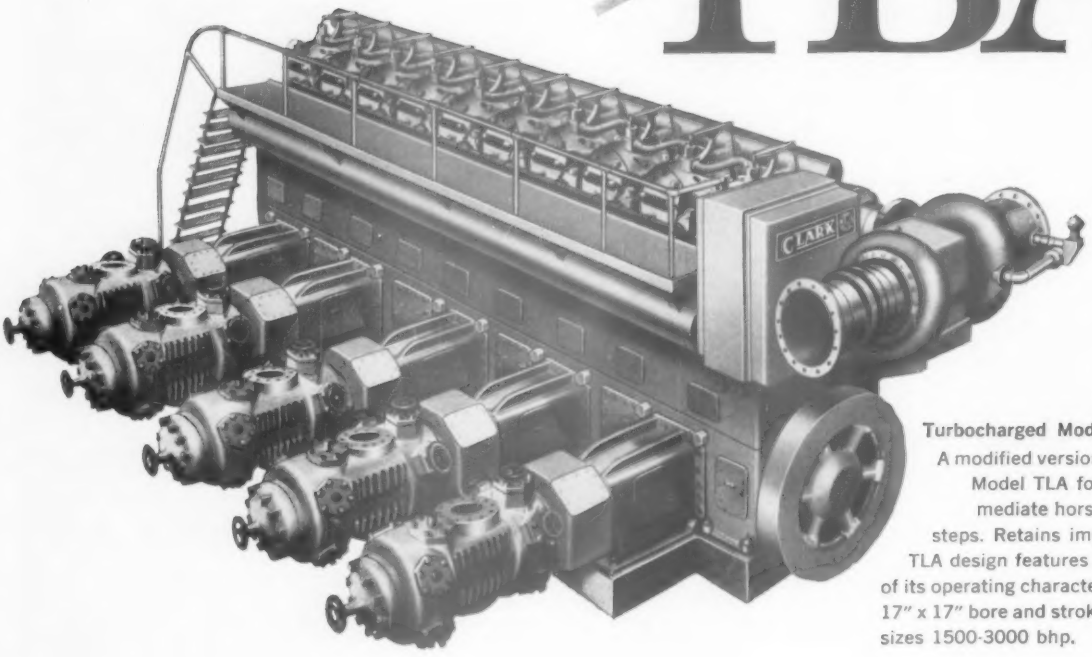


Popular Model TLA
Over 600,000 installed horsepower of this famous turbocharged, 2-cycle gas-engine-driven compressor testify to its superior performance, ruggedness and economy of operation. 17" x 19" bore and stroke. Four sizes 1700-3400 bhp.

the CLARK TLA TBA



Turbocharged Model TBA
A modified version of the Model TLA for intermediate horsepower steps. Retains important TLA design features and all of its operating characteristics. 17" x 17" bore and stroke. Four sizes 1500-3000 bhp.

Now you can name the horsepower—from 1500 to 3400 bhp—and name Clark with confidence. Clark has the compressor to fit your needs *exactly!*

With the addition of the TBA Series (a modified version of the time-tested Model TLA 2-Cycle, Gas-Engine-Driven Compressor), Clark now offers eight closely graduated sizes in this important horsepower range for pipeline and process applications.

The TBA is carefully matched to the TLA, giving you not only the best horsepower choice, but also a machine you can trust. Here's how it's done:

Same Heavy Duty Construction—The TBA incorporates the lower crankcase with thru-bolts, crankshaft, power pistons, compressor cylinders, aluminum bearings and running gear of the TLA—all thoroughly proved in exacting field duty. Both machines are specifically designed to handle the high power delivered by turbocharging.

Same High Efficiency Turbocharging System—The Clark designed, constant pressure turbocharger provides a flexible supply of combustion air that varies in proportion to the load placed on the engine. Thus the fuel-air ratio is inherently correct over the entire operating range.

Same Operating Flexibility—The turbocharger system coupled with a new automatic ignition timing control makes the TBA and the TLA ideally suited for variable speed, variable load applications. The fuel consumption curve remains essentially flat over a wide range . . . from reduced speeds at constant or variable torque all the way up to substantial emergency overloads at rated speed.

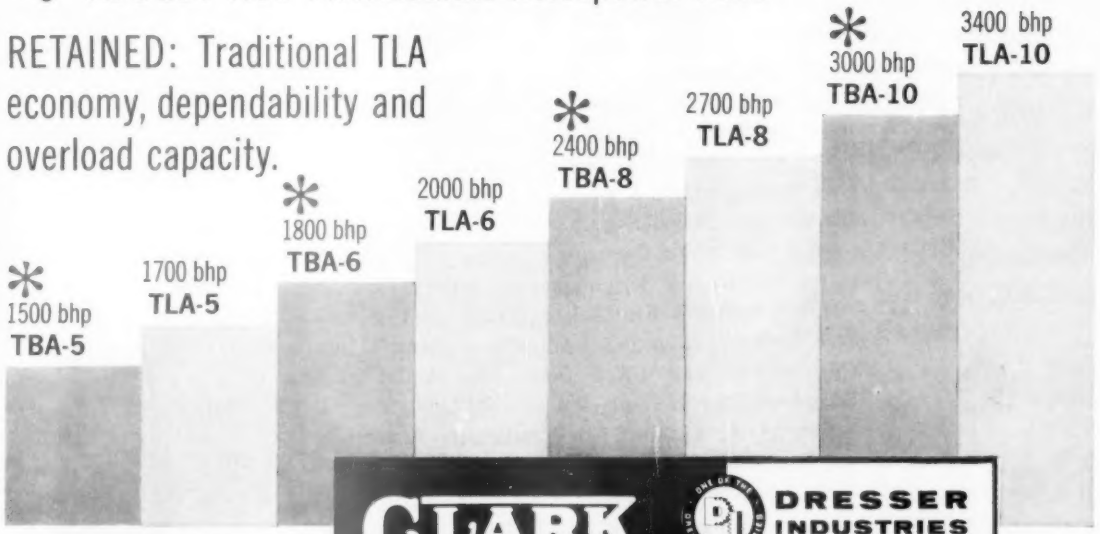
What's different, then? The stroke on the TBA has been shortened from 19″ to 17″, the external configuration of the power cylinders has been modified, and the ratings have been changed in accordance with the new stroke length. The TBA is built in five, six, eight and ten power cylinder models rated at 1500, 1800, 2400 and 3000 bhp respectively.

More facts are yours for the asking. Write for new Clark TBA Bulletin 206, and new TLA Bulletin 225.

Line is IN STEP with your pipeline or process requirements

* ADDED: New intermediate horsepower sizes

RETAINED: Traditional TLA economy, dependability and overload capacity.



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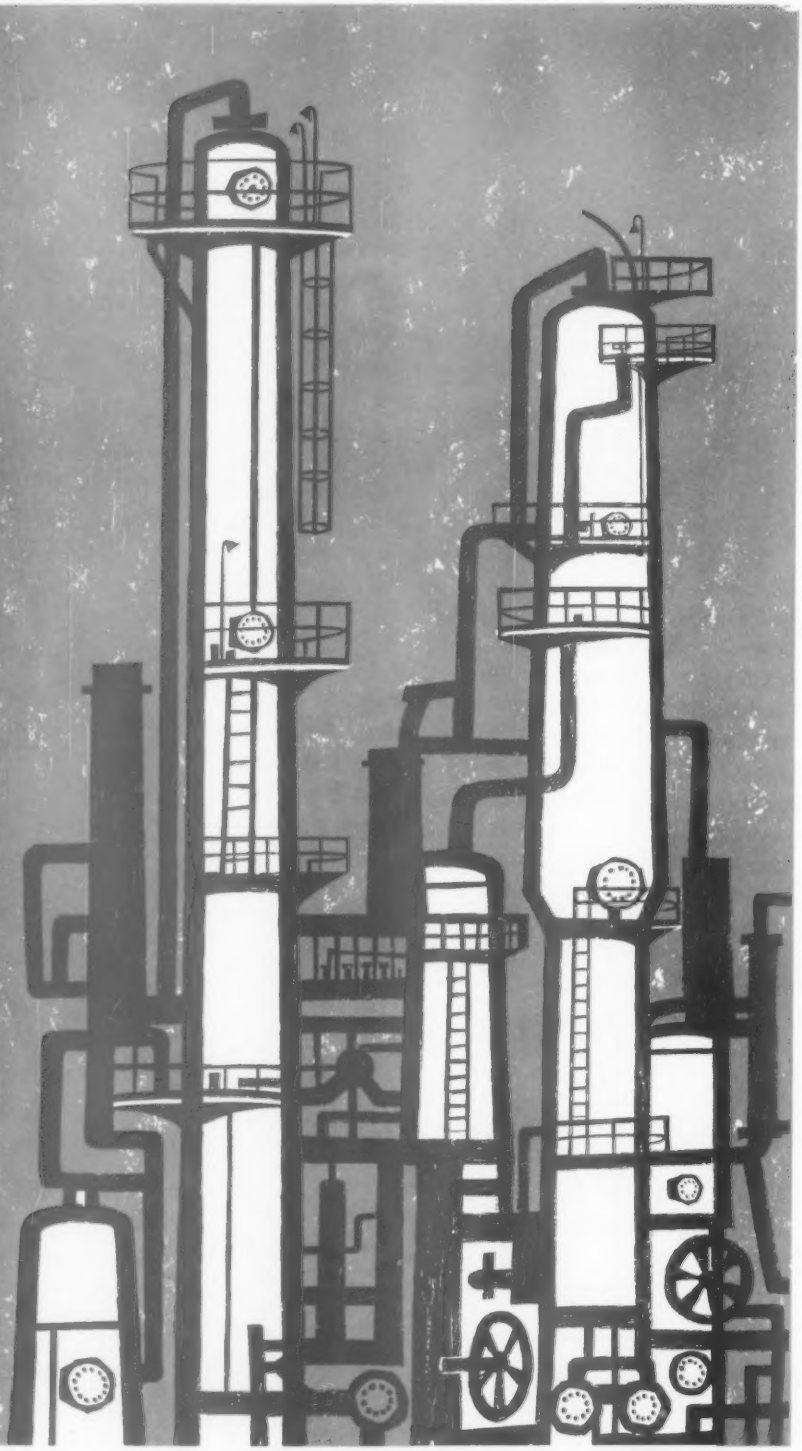

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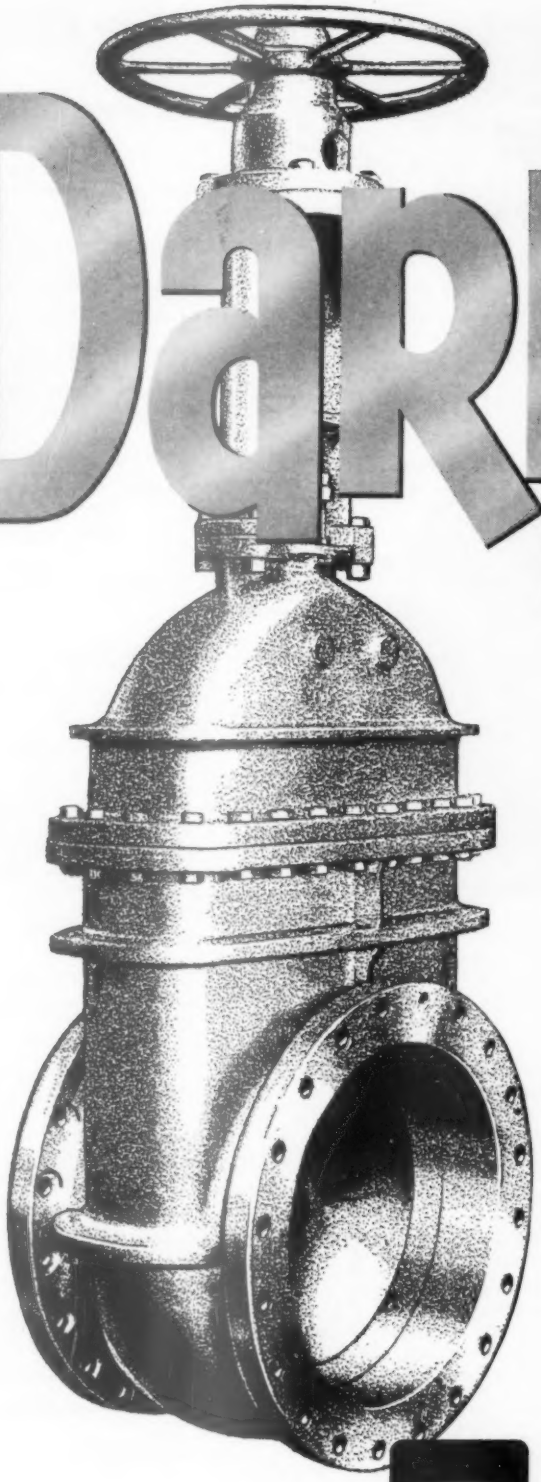

Darling aluminum gate valves resist corrosive attack from chemicals such as hydrogen peroxide, ammonium nitrite, acetic acid and concentrated nitric acid. In such services *you can depend on Darling* aluminum gate valves to last longer, cut maintenance costs.

Darling metallurgists tested—then standardized—on aluminum alloys that provide maximum strength and corrosion resistance. Rigid quality control and precision assembly assure continuous ease of operation. The exclusive revolving double disc parallel seat feature means freedom from leakage and assures long service life.

Darling aluminum gate valves are available in sizes from ½″ through 24″. We will be glad to make recommendations.

SPECIAL ENGINEERING SERVICE. Darling engineers are ready to work with you in designing special valves to meet unusual service requirements. Write, wire or phone for prompt action.

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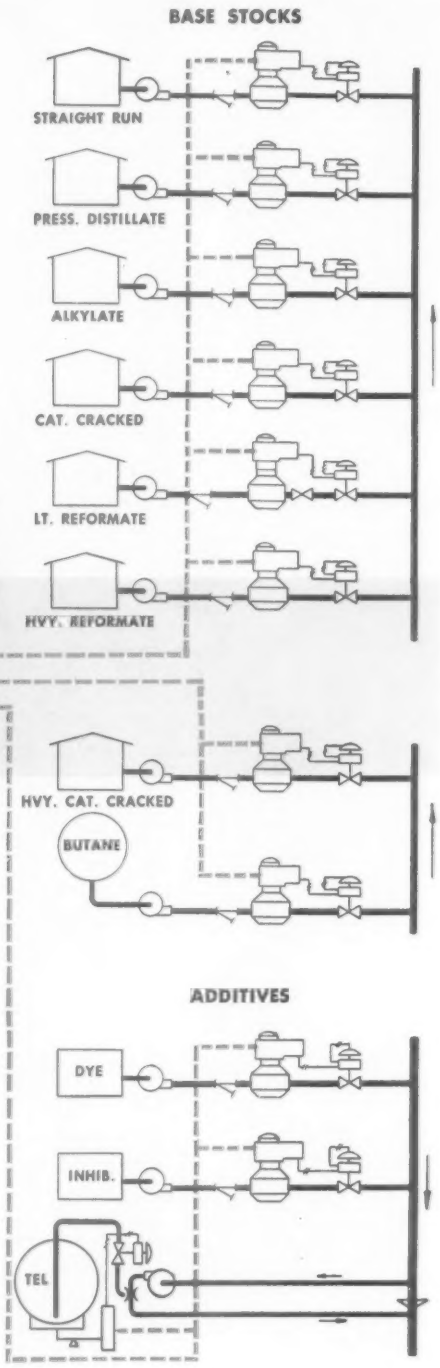
ON STREAM!

FIRST ELECTRONIC BLENDER

... AT WILSHIRE OIL

NEW BIF *Proportioneers* BLENDER

- Cuts Blending Time In Half
- Reduces Operating Costs
- Achieves Maximum Efficiency in Minimum Space



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- Digital control combined with instantaneous response sets new highs in specification accuracies.
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- Compact control console can be located at most convenient spot *away* from blend manifold.
- Exclusive interchangeable modular construction increases flexibility . . . cuts maintenance . . . facilitates servicing.
- Preformulation "dry run" tests save product.
- Electronic field service eliminated with single replaceable module.
- Only electronic blender with memory feature.
- Automatic setting — statically from punched data cards — dynamically from customers computer center.

Dependable Proportioneers stream blending systems are producing blends from base stocks throughout the world without intermediate tankage, cutting investment and operating costs, increasing production. The new electronic console makes this proven system even better!

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Write for complete data.

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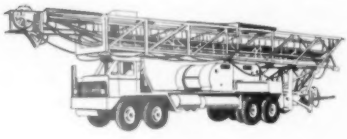
The Man Who . . .

PULLS OIL WELLS OUT OF TROUBLE.

When you're in trouble you look for a friend that you can depend on . . . just as oil men depend on servicing contractors to keep their wells pumping at top efficiency. And, experience teaches that the most dependable contractor is the one with **good equipment . . .** like Franks . . . equipment engineered and built to keep the contractor as well as the producer out of trouble. **So, next time you are faced with servicing problems, look for** **proven dependability. Ask the man who uses Franks . . .** about the equipment that keeps him out of trouble.



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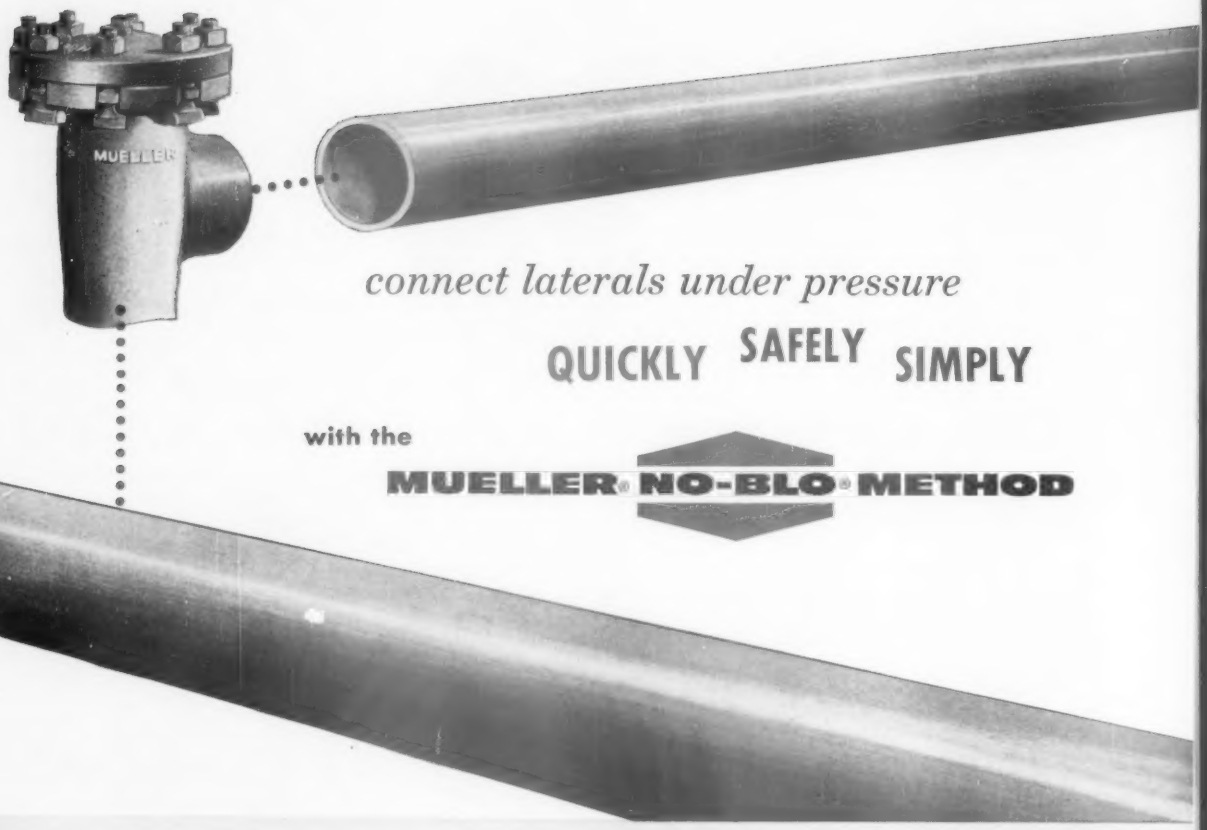


connect laterals under pressure

QUICKLY SAFELY SIMPLY

with the

MUELLER® NO-BLO® METHOD

■ *Only these simple operations are needed to quickly connect a 4" lateral under pressure to a steel line with a No-Blo Flanged Tee.*

1. WELD

Remove cap and loosen plug. Weld Flanged Tee to line. Weld lateral to Flanged Tee. Complete lateral to first shut-off. Test welds with soapsuds. Bolt gate valve—hand tight—to fitting and open valve.

2. ALIGN

Attach alignment tool and completion plug to shaft of H-17235 Stopping Machine. Bolt machine—hand tight—to gate valve. Align machine and valve with fitting. Insert plug into fitting and tighten bolts. Mark position of machine on valve. Remove completion plug and machine.

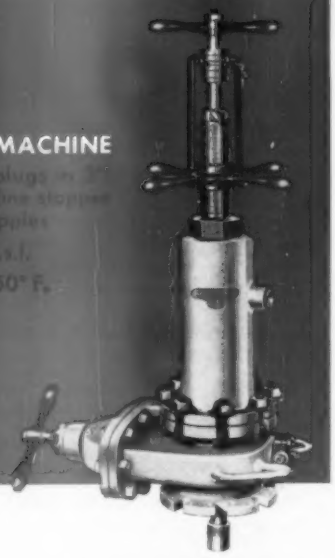
3. ASSEMBLE

Bolt adapter to CH-6 Drilling Machine. Advance boring bar with rapid feed hand crank. Attach cutter arbor, pilot drill and shell cutter to boring bar. Retract boring bar to rearmost position. Bolt machine to the open gate valve.

Write for complete information and specifications.

H-17235 STOPPING MACHINE

... inserts and extracts plugs in 3" and 4" flanged tees, line stopper fittings and drilling nipples
... for pressures to 100 p.s.i.
... for temperatures to 250° F.
... hand operated



These machines and fittings are just a small part of Mueller's complete system of No-Blo products—products especially designed for working with fluids under pressure.

■ Large lateral line connections can be made to existing lines in just a few minutes when your crew is equipped with a Mueller CH-6 Drilling Machine and H-17235 Stopping Machine. These compact machines are ideal for connecting 3" and 4" lines under pressure. Automatic operation of the "CH-6" simplifies the operator's job, assures safe operation and saves time.

CH-6 DRILLING MACHINE

... makes cuts from 2" to 6"
... shell cutters designed for cutting any type pipe
... up to 24" boring bar travel
... for pressures to 1440 p.s.i. at 100° F.
... for temperatures to 500° F. at 1250 p.s.i.
... features automatic operation without supervision
... automatic feed disengagement and over-travel protection
... direct reading tool position and feed indicators
... telescopic design for handling ease
... self-adjusting boring bar packing
... for power operation with air or gasoline engine drive unit
... may also be operated by hand

4. CUT

Test set-up for pressure tightness. Advance boring bar until pilot drill almost contacts line. Set amount of cut needed and engage automatic feed. Mount air motor on machine and open throttle. ("CH-6" will automatically make cut and disengage feed without supervision.) Lateral now in operation. Retract boring bar to rearmost position. Close gate valve and remove machine.

5. PLUG

Fasten inserting tool and completion plug to shaft of "H-17235." Bolt machine to gate valve in same position as marked. Open gate valve and insert plug solidly into top of fitting. Test tightness of plug with bypass valve. Release plug and remove machine and gate valve.

6. CAP

Position gasket on flange of fitting. Bolt completion cap firmly in place. Test entire set-up with soapsuds. Connection now completed and ready for backfilling.

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BETTER COATINGS THROUGH RESEARCH

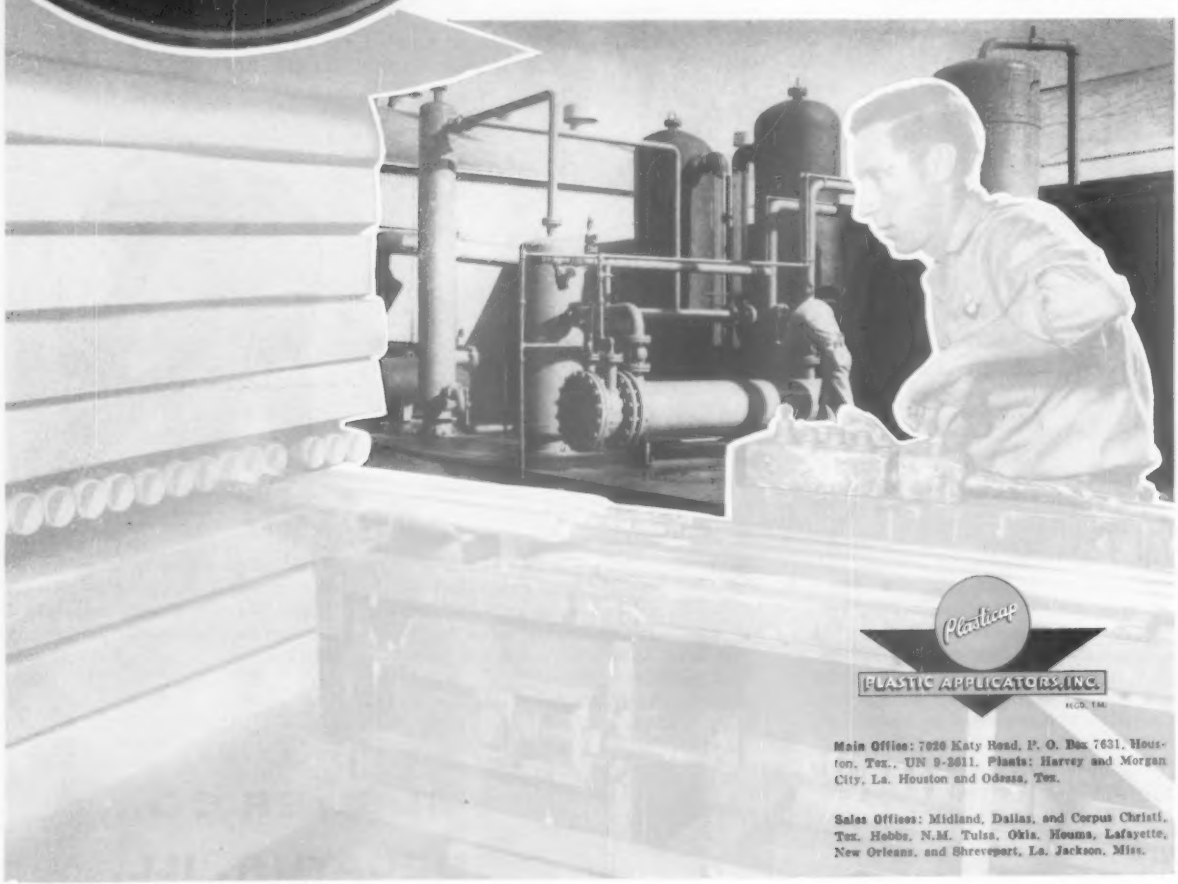
RESEARCH EFFORT: ***To provide ever-improved plastic coatings to our customers by developing even better methods of insuring maximum quality and purity of Plasticap coatings applied to tubular goods.***

RESULT: ***Air dehydrators have been installed at all Plastic Applicators plants to remove water, oil, and other impurities from air used in applying Plasticap coatings.***

• Furnishing the best possible plastic coatings to the oil industry is the number-one task at Plastic Applicators. Therefore a continuous high-priority research program is conducted in our own laboratories and in those of independent research organizations under contract to Plastic Applicators.

• Among the many advances that have come from this sustained research program was confirmation of the fact that conventional air-cleaning equipment does not completely remove airborne water and oil. Remaining water and oil can form emulsions that are harmful to plastic coatings. To eliminate this possibility, Plastic Applicators has installed air dehydrators at each of its plants to remove all water, oil, and other impurities from air used in applying Plasticap coatings.

PROTECT YOURSELF AND YOUR PIPE. SPECIFY PLASTICAP. MORE TUBULAR GOODS ARE PROTECTED WITH PLASTICAP THAN ANY OTHER COATING.



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They Say—

'Sidelights' gave wrong slant

Dear Sir:

I'd like to draw your attention to what I consider an unfortunate choice of words used in your report on the Midland hearing of the Federal Power Commission (OGJ, Mar. 13, p. 85).

The tone of the "Sidelights From the Hearing" which accompanied your report is one that does not serve the industry's best interests.

You said that "scores of small producers had been dragooned from all over West Texas to demonstrate that all gas isn't produced by just a few big corporations." No one was dragooned. A total of 372 producers filed statements of their positions with the FPC 3 weeks before the prehearing conference.

The proposal to go off the record was a proper one. But your account made it sound sneaky by referring to "private caucuses in smoke-filled rooms."

A wrong impression of the tone of the meeting was given, I feel, in a number of flippant remarks concerning horrified public relations men, pleas for cooperation, and suggested use of applause meters to weigh the validity of evidence.

This was an informal hearing with no strict procedural formalities. The examiner actually held a tight rein on the meeting. He could have stopped applause, but not once did he try to do so.

We all make our share of mistakes. I believe you made one in adding these "Sidelights" to what otherwise was an informative report on this important hearing.

Jake L. Hamon
Dallas

Is per cent a true test?

Dear Sir:

Your editorial on page 73 of the March 6 issue entitled "Two Dozen Men Could Cure the Runs Problem" is a forceful statement of a vexing problem, and we find ourselves in agreement with your general conclusion.

However, one of the basic pre-

mises of the editorial is, we believe, incorrect and could lead to an erroneous conclusion. This relates to attaching so much weight to refinery operations in terms of per cent of operable capacity.

We do not wish to burden you with a lot of detail on this point and are sure you realize that if the premise is doubtful a number of possibilities for error would arise from its application to specific cases.

For example, one company might substantially increase its refining facilities. This would serve to reduce its rate of runs in per cent of capacity. It would be unfair to compare that company's performance with another company which had made no change in its operating capacity and would, therefore, seem to be running more crude than it should.

The capacity yardstick would also be distorted in the case of a company which absorbed in its own operations the refining of crude formerly run for it by other refiners.

The test lies not in the amount of capacity nor in the rate of crude runs as a per cent of capacity. It lies, rather, in the volume of crude a company runs in relation to its previous runs.

Consider our own case. In the years 1957 through 1960, we reduced our crude runs by 11%. In the single year 1960, our runs were 5% under those for 1959, in addition to which we purchased 20,000 bbl. daily of products from other refiners in an effort to help alleviate the industry-wide oversupply.

In the week ending March 3, 1961, Cities Service refinery runs averaged 22,450 bbl. per day less than in the same week last year. This is a decrease of 8.5%, while in the same week refinery runs for the industry as a whole increased 7%. Yet, because of factors above related, our runs in terms of per cent of capacity would seem to be on the high side.

I know of no company which has been more careful in the control of its inventories than ours. We have done our level best to keep our supplies in balance with our sales requirements, and have succeeded in doing so.

The principal problem of the oil industry, as we stated in our 1960 annual report, is not the existence of excess capacities, but is rather the intelligent and realistic management, by competing units of the industry, of this surplus capacity.

B. S. Watson
Chairman of the Board
Cities Service Co.

Welding question raised

Dear Sir:

The article on double-jointing for pipelines (OGJ, Feb. 13, p. 70) is very descriptive and informative. It will be quite valuable to the industry.

The first part of the conclusions should be amplified or changed somewhat. I would suspect that superior weld quality is not obtained by the inside bead at all. Beneficial annealing effect can be obtained by welding from the outside.

In fact, you would probably obtain a much greater beneficial annealing effect by welding from one side only. Each weld pass, deposited on the previous one, anneals the previous pass. It is the last pass that receives no such annealing effect.

Probably the most beneficial effect of the inside bead is to produce a uniform distribution of residual stress throughout the wall thickness of the pipe. I am convinced that there is some importance to this, but how much should be placed on it I am not prepared to say.

Robert S. Ryan
Supervisory Engineer
Columbia Gas System
Service Corp.

Letters to They Say should be addressed to The Editor, The Oil and Gas Journal, Box 1260, Tulsa, Okla.

Not a New Issue

59,640 Shares

Eason Oil Company

Common Stock

($1 Par Value)

All of these shares having been sold, this advertisement appears as a matter of record only.

LEHMAN BROTHERS

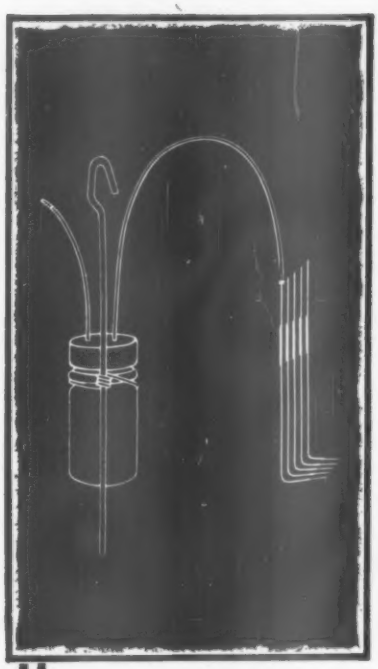
March 30, 1961.

CALENDAR

APRIL

- **4** Instrument Society of America, New Jersey section, annual symposium on electronic process instrumentation, Hotel Essex House, Newark, N. J.
- **4-5** University of Kansas, gas compressor institute, Liberal, Kans.
- **5-6** Third annual symposium on pilot plant and process automation, Ambassador Hotel, Los Angeles.
- **5-7** American Petroleum Institute, Division of Production, Mid-Continent district meeting, Mayo Hotel, Tulsa.
- **6-7** University of Oklahoma, School of Mechanical Engineering, short course on industrial engines, University of Oklahoma, Norman.

CANNON PENS



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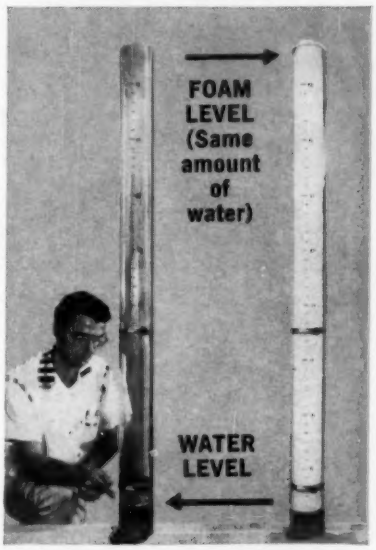
6-8	Texas Oil Jobbers Association, Petroleum Marketers Association, convention and trade show, Baker Hotel, Dallas.
8-12	Petroleum Equipment Suppliers Association, annual meeting, The Greenbrier, White Sulphur Springs, W. Va.
9-11	Society of Exploration Geophysicists, fourteenth annual midwestern exploration meeting, Skirvin Tower Hotel, Oklahoma City.
10-11	American Society of Mechanical Engineers, maintenance and plant engineering conference, Bancroft Hotel, Worcester, Mass.
10-12	Western Petroleum Refiners Association, annual meeting, Granada Hotel, San Antonio, Tex.
10-13	American Society of Mechanical Engineers, oil and gas power conference and exhibit, Jung Hotel, New Orleans.
11-13	Petroleum Industry Electrical Association and Petroleum Electric Supply Association, annual conference, Moody Convention Center, Galveston, Tex.
12	Independent Oil Producers and Land Owners Association Tri-State, and Independent Petroleum Association of America, joint meeting, McCurdy Hotel, Evansville, Ind.
12-14	Investment Bankers Association of America, annual convention of the Texas group, Shamrock Hilton Hotel, Houston.
14	American Institute of Chemical Engineers, St. Louis section, third annual symposium, Coronado Hotel, St. Louis.
14-15	Tulsa Geological Society, Fort Smith Geological Society, joint field trip to the Arkoma basin, registration, Goldman Hotel, Fort Smith.
17-19	Instrument Society of America, symposium on instrumental methods of analysis, Shamrock Hilton Hotel, Houston.
18-20	University of Oklahoma, southwestern gas measurement short course, North Campus, University of Oklahoma, Norman.
19-20	University of Tulsa, fifteenth annual conference of accountants, University campus, Tulsa.
19-20	National Petroleum Association, semi-annual meeting, Hotel Sheraton-Cleveland, Cleveland.
20-21	Society of Petroleum Engineers of AIME, East Texas-Louisiana-Arkansas gas-technology symposium, Tyler, Tex.
20-21	Texas Technological College, annual West Texas oil lifting short course, Lubbock, Tex.
20-22	Illinois Society of Professional Engineers, annual convention, Peoria, Ill.
24-26	Southern Gas Association, meeting, New Orleans.
24-27	American Association of Petroleum Geologists, Society of Economic Paleontologists, and Rocky Mountain section of AAPG, annual meeting, Denver Hilton Hotel, Denver.
26-28	American Petroleum Institute, Division of Transportation, pipeline conference, Chase-Park Plaza Hotel, St. Louis.
27-28	Rocky Mountain Oil and Gas Association, midyear meeting, Northern Hotel, Billings, Mont.
28	Natural Gasoline Association of America, Oklahoma regional meeting, Lake Murray Lodge, Ardmore, Okla.

efficient foaming agents– to remove fluids from wells



Dowell foaming agents are designed to cause fluids to foam when aerated by gas or air.

When foaming occurs, fluid density is reduced and well unloading is simplified.

Foaming agents have been used successfully to unload gas wells and oil wells that produce some gas. Produced water or oil—as well as spent acid or fracturing fluids used for stimulation—have been unloaded. Usually, formation energy has been sufficient to unload the fluid. In instances where swabbing was required, swabbing time was reduced to a minimum.

Foaming agents have also been used to unload produced water from wells during air drilling operations.

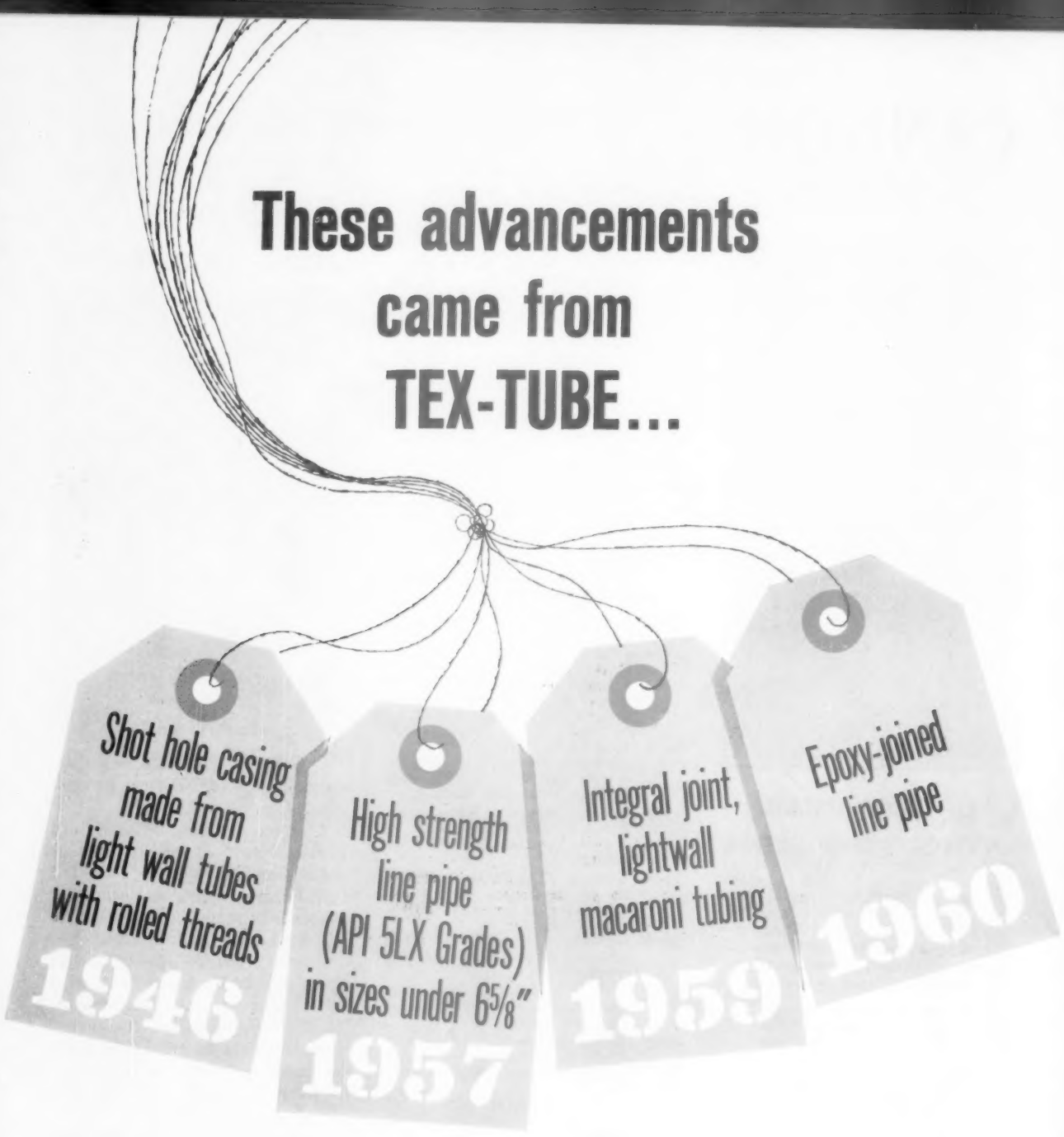
Dowell foaming agents are offered in three types. G-2 is a water-soluble liquid; G-4 is an oil- and water-soluble liquid; G-5 is a water-soluble stick. All are available from any Dowell station.

PRODUCTS FOR THE OIL INDUSTRY

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

These advancements came from TEX-TUBE...


Shot hole casing made from light wall tubes with rolled threads
1946
High strength line pipe (API 5LX Grades) in sizes under 6⅝"
1957
Integral joint, lightwall macaroni tubing
1959
Epoxy-joined line pipe
1960

One more reason why we say – when you specify TEX-TUBE, you get the best – first!

Each of these technological advancements was developed and introduced to the industry by Tex-Tube. Since 1946, when Tex-Tube was founded, big ideas have rolled with every foot of pipe. And more are on the way. New cost-saving, quality-improvement ideas are being developed and field-proved right now. At Tex-Tube, our expenditures on Research & Development are *investments for you.*

When you need pipe, specify Tex-Tube—and know that you get the best—*first!* Tex-Tube, Inc., The Little Mill with The Big Ideas, 1503 North Post Oak Rd., Houston, Texas. Sales offices in Midland, Dallas, Denver, Tulsa and Los Angeles.

Pipe Manufacturers: High Tensile Lightwall Pipe / Oil Well Casing / Oil Well Tubing / Structural and Mechanical Tubing / Shot Hole Casing / Upsetting, Threading, Normalizing

TEX TUBE THE LITTLE MILL WITH THE BIG IDEAS!

the Journal said...

50 years ago

April 6, 1911

Newly issued report of the USGS lists the deepest well in the United States as being near West Elizabeth, Pa. It was drilled to 5,575 ft. The world's deepest well is in Germany with total depth at 6,575 ft.

Logan County, Ohio, is getting to be quite an oil and gas center. Prospects are good for the location of oil-field supply stores. Not only oil but possibilities of important extension of gas production from nearby fields also are considered worth looking after.

Important oil deals in the making include the purchase by W. M. Graham and his New York associates of Charles Page's properties in the Taneha district of Oklahoma for $1,000,000; acquisition by A. Morton, Bartlesville, of various producing properties in the Cherokee and Creek districts of Oklahoma for $3,000,000; and Palmer Annex Oil Co.'s sale of a half interest in its Cat Canyon, California, holdings for $2,500,000.

25 years ago

April 2, 1936

Oklahoma City voters approve additional town-lot oil operations in capitol area. Drilling right extended to mile-square zone immediately north of state property. Locations made for 53 wells in new flurry of activity.

New Mexico's biggest oil well to date comes in with open flow of 1,243 bbl. in 1 hour. Barnsdall Oil Co.'s 4 Cooper, in Monument field, in Lea County, is record holder. Flow in 24 hours restricted through ¾-in. choke to 4,800 bbl.

Daily oil production in both Louisiana and Kansas climbs to record high levels. Daily average for week totals 203,100 bbl. in Louisiana, and 159,625 bbl. in Kansas.

10 years ago

April 5, 1951

First natural gas from any field in the Gulf of Mexico moves to market with completion of pipeline from Pure Oil Co.'s Rollover field in Block 39, Vermilion Area, 10 miles off the coast of Vermilion Parish, Louisiana. New offshore 8⅝-in. line, operated by Marine Gathering Co., delivers gas on shore to Tennessee Gas Transmission Co. Initial movement from four wells at Pure's producing platform totals 10 M.M.c.f.d.

Hearings open at Bartlesville into gas operations of Phillips Petroleum Co. in move toward first real test of authority of Federal Power Commission to regulate independent producers and gatherers of natural gas.

JOURNALLY SPEAKING

Above Potatoes

DOES YOUR oil company have a "Director of Intelligence Services"?

If not, it ought to, according to some students of business. And at the rate things are going it may have to have such before too long.

A company director of intelligence services is not, as you might guess, a superespionage outfit, comparable to the Government's Central Intelligence Agency, set up to spy on what employes and competitors are doing.

No, he would be a member of an entirely new profession, a profession that doesn't even exist yet, and trained in a science that has still to be developed—the science of decision making.

The philosophy behind this is that in these times a business executive has to make so many decisions, and such complicated ones, that he needs expert advice from a professional decision maker.

The classic story about decisions concerns the hired man who could do the hardest kinds of farm work without batting an eye but who was thrown into a nervous sweat by all the decisions involved in sorting potatoes. The implication is that a good business executive is simply one who has a knack for sorting potatoes.

But nowadays the potato-sorting type of decision isn't enough to operate a business properly. Management must rise above the potato level.

Making decisions, it is argued, can no longer be considered a knack or an art. It must be reduced to a science. And the corporate practitioners of that science will be known as directors of intelligence services.

The directors of intelligence services will not be the managers of business organizations. They will simply be expert advisers to top management, taking a place on a par with the general counsel, comptroller, research director, marketing head, and similar top-echelon staff specialists.

The director of intelligence services will not determine policy for the company, but he will be an expert on how policies ought to be made and will guide top management in making them properly.

He will help management cope with the growing masses of data that have to be considered in making any policy decision these days—doubtless processing it all through an electronic computer.

The reason for his title is that the director of intelligence services will spend his time gathering information that will make his boss intelligent. He will measure the effects of present policies, forecast the probable effects of alternate policies, relate technical specifics to broad courses of action, and reduce unknown factors to the minimum.

So when the board of directors meets to make a decision it will have before it a complete report showing exactly what will happen all up and down the line, immediately and in the future, if it adopts Course A, or Course B, or Course C. It will all be entirely scientific, completely eliminating guesswork in determining company policy.

Wouldn't this be wonderful?

Just think what the oil business would be like if every company, large and small, followed policies based on the findings of directors of intelligence services trained in the science of decision making.

There would be no more rhubarbs over such things as whether or not refinery runs are too high, or tank-wagon prices too low.

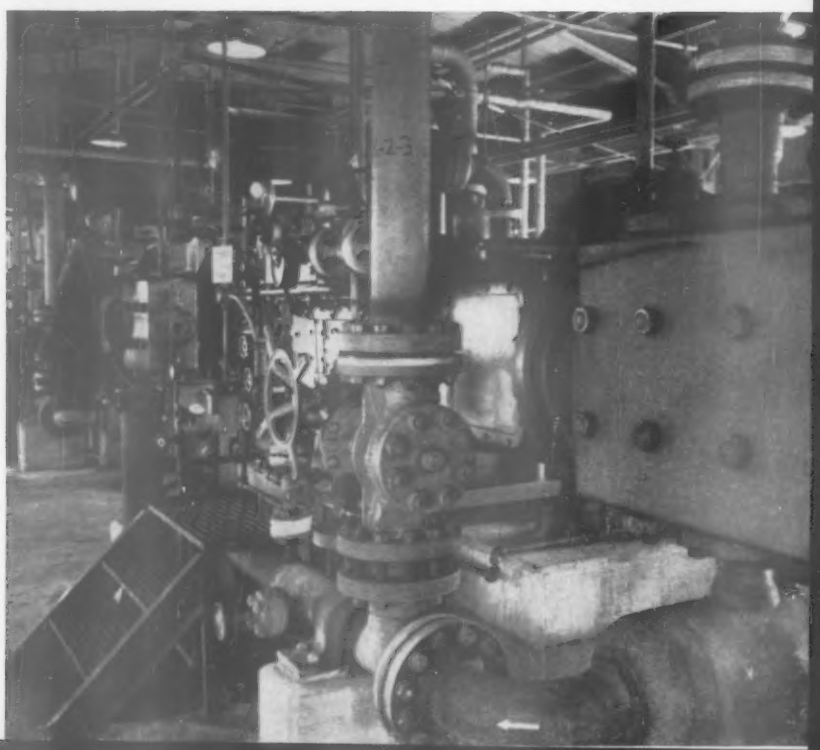
The president of every company would know that if he keeps his stocks of each petroleum product at a predetermined level, and sticks to a prescribed price structure and merchandising program, his customers and his competitors will react in a given manner and his earnings will be a specific amount.

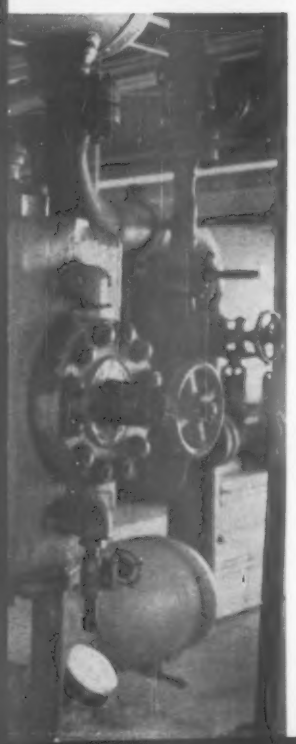
Yup, the oil business could use some directors of intelligence services, all right. But until some of them get established in enough places it looks as though the industry will have to keep on picking up one potato at a time and guessing whether it should be stored, baked, mashed, or fed to the hogs.

—Henry D. Ralph

A 1200 hp Cooper-Bessemer Type FM Compressor which transfers make-up hydrogen to the hydrodesulfurization plants.

600 hp Cooper-Bessemer Type FM Compressors recycling hydrogen within the naphtha (gasoline) hydrodesulfurization plant.





How 7 Cooper-Bessemer Compressors put 700 psi behind sulphur removal

Hydrodesulfurization at Wood River... Shell Oil Company's largest refinery... removes sulphur from 25,000 barrels of high octane gasoline and 25,000 barrels of fuel oil daily. In this process, the job of compressing hydrogen to 700 psi for removal of sulphur belongs to six Cooper-Bessemer Type FM motor-driven compressors. And a seventh FM unit compresses the hydrogen sulphide product to 100 psig for the manufacture of free sulphur... an output of 100 tons per day.

These 7 Cooper-Bessemer Compressors operate 24 hours per day, 7 days per week. Two units are 1200 hp; four are 600 hp and one is 400 hp... all running at 450 rpm.

Cooper-Bessemer engineers will gladly help *you* plan compression and power facilities for refining and petrochemical processing. Write for a copy of "Cooper-Bessemer Equipment for Refineries."

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How to beat gas at its own game

THE OIL INDUSTRY is finally concentrating attention on its long-neglected stepchild, home-heating oil.

Two distributor groups have merged into a new and stronger National Heating Oil Institute to improve promotion and service, and the API is launching a program of research into distillate's combustion characteristics and efficient burner equipment.

Here is a field that promises big results in an expanded demand for petroleum, and it is one that has been in sore need of attention for a good many years.

THE RETAIL MARKET for residential and commercial use of heating oil is worth about 2½ billion dollars to the oil industry, and it represents about one-eighth of the domestic demand for all petroleum products.

But the industry as a whole did relatively little to foster this market. For many years it "just growed," like Topsy. Some equipment makers developed pretty good burners, some dealers marketed aggressively, and most refiners improved quality of No. 2 oil.

No concerted program was needed to crowd coal out of the home-heating market. For several years after the end of World War II the demand for distillate fuels increased about 10% every year. Then the growth rate fell off and currently is about 2% a year.

The explanation is competition from natural gas. Since the war U. S. sales of distillate and range oil for heating doubled and are now 430,000,000 bbl. per year. But during the same period residential and commercial sales of gas quadrupled and are now the equivalent of 650,000,000 bbl. of heating oil.

This can't all be blamed on government actions holding gas prices to an arbitrary low level. In some areas gas has displaced oil even though it gives the average home owner a higher heating bill. It is due to cooperation between gas companies and equipment makers in developing better appliances and to aggressive promotion, merchandising, and servicing.

OIL IS BELATEDLY adopting the tactics of its gas competitor. Already the program has pinpointed several promising areas for attack, such as assisting distributors' promotion and servicing, working with home builders, and modernizing municipal building codes.

But the heart of the project is low-cost, efficient, trouble-free burners. The research aims for some real breakthroughs to outdistance the sporadic cut-and-try efforts of individual manufacturers, most of whom are discouraged by the dropoff in burner sales.

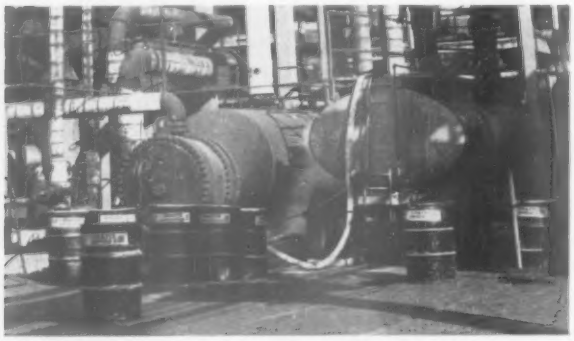
There is still a big growth potential for oil in the home-heating field. But to realize it, the industry cannot leave development to those on its fringes. The current concerted program to expand demand for heating oil is a welcome manifestation of the "new" oil industry.

Oakite ECP
engineered cleaning program

speeds turnarounds, cuts maintenance costs

Oakite ECP stands for Engineered Cleaning Programs. It is chemical cleaning tailored individually for specific refineries to give the shortest turnaround time consistent with good results. Each ECP takes into account a refinery's particular conditions, equipment, through-put. It itemizes the problems involved, and suggests methods and materials to solve those problems. In putting the chemistry of cleaning to work, it utilizes the experience of Oakite engineers, the latest research results and the skills of laboratory and field technicians.

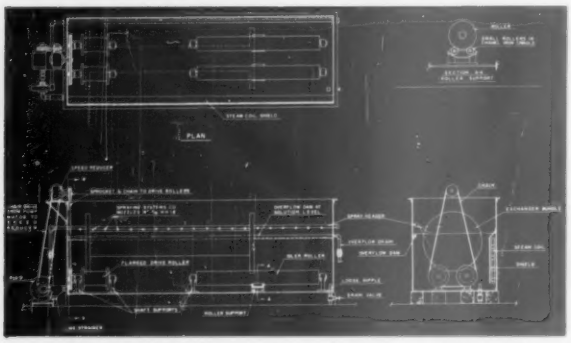
IT MAKES SPECIFIC RECOMMENDATIONS. An Oakite ECP spells out the whole course of cleaning action—from valve to tower. It estimates the material quantities needed and off-stream time expected for specific items of processing equipment and refinery maintenance. The world's finest laboratory facilities engaged in cleaning research cooperate in analyzing stubborn soils, recommend suitable cleaners, and implement the Oakite petroleum engineers' knowledge of refinery cleaning.



IT'S COMPREHENSIVE. If the equipment needs cleaning, an Oakite ECP accommodates it. For example:

Process Equipment Cleaning
- Bubble cap, cascade and perforated tray type towers
- Raschig ring towers
- Heat Exchangers
- Condensers
- Reboilers
- Preheaters

General Refinery Maintenance
- Storage tank cleaning
- Tank car and truck cleaning
- Reclamation of valves, fittings, pipe
- Drum washing
- Cleaning for safety and appearance

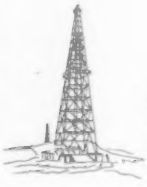


IT GIVES ENGINEERING DETAILS. You get engineering drawings of recommended set-ups for in-place cleaning, cleaning in tanks, etc. A fully staffed engineering department develops standard mechanized cleaning units with a wide variety of refinery uses. Among these important developments, the "Hurriclean" Steam-Detergent Gun removes caked-on soils from salvage parts too large for tank immersion, the Interior Tank Cleaning Unit expedites change-overs in cars and barges. The portable Hot-Spray Unit mechanizes cleaning in and around pump houses.

IT OFFERS HELPFUL BOOKLETS. Among the various factual and job-aiding data available from Oakite are these three booklets covering the cleaning jobs of major importance. Send for them without obligation. Ask also for more details on Oakite Engineered Cleaning Programs—or better still, ask your local Oakite man to develop one for you and and demonstrate its benefits. Oakite Products, Inc., 44C Rector Street, New York 6, N. Y.

OAKITE
SCIENCE
Est. 1909
over 50 years' in industrial cleaning

OAKITE ECP benefits you from the ground up . . .



at drilling site it speeds such salvage operations as paint stripping, rust removal, degreasing

it restores pipeline efficiency through chemical cleaning... it simplifies pump station housekeeping

It simplifies and speeds up column and tower maintenance through in-place chemical cleaning.

The Journal **FORECAST** of U. S. **REFINING**

	CAPACITY			CONSTRUCTION	
	Jan. 1, 1961	% Gain over Jan. 1, 1960	Est. % Gain by Jan. 1, 1962	1961	1962
Crude BPCD	9,933,725	1.5	0.7	72,665	22,000
BPSD	10,499,820	1.3	0.7	73,535	23,000
(Feed, BPSD)					
Thermal cracking	1,903,555	—6.2	2.6	50,200	11,000
Cat cracking	5,014,286	4.8	4.4	221,000	13,000
Cat reforming	1,963,214	2.6	2.7	53,300	30,000
Hydrogen treating	2,218,559	14.3	6.1	136,000	25,300
Cat hydrocracking	1,000	0.0	1,000.0	10,000	41,500
(Product, BPSD)					
Alkylation	425,091	4.3	3.2	13,500	18,700
Polymerization	150,419	1.4	0.0	0	0
Isomerization	50,925	0.1	0.0	0	8,800
Lubes	189,870	4.0	1.0	2,000	0
Coke (tons per day)	16,903	4.4	8.2	1,380	460

Refiners' Capacity Still Growing

● Burdensome over capacity will exist in U. S. for some years. Big gains in hydrogen-treating, cat-cracking capacity were made in 1960.

Kenneth Brooks
District Editor

THE NATION'S crude capacity inched up slightly last year widening the gap between capacity and runs by 0.6%.

Most construction was centered around downstream processes such as catalytic cracking and hydrogen treating.

But even so, the net additions to crude capacity—144,000 bbl. per calendar day—exceeded the increase in crude runs last year. The result: Refiners operated at 81.8% of rated capacity as compared to 82.4% in 1959.

This year little reduction is expected in this refining capacity cushion.

Crude capacity now stands at 10,499,820 bbl. per stream day, up 1.3% over January 1960. Construction now under way will boost this figure 74,000 bbl. by 1962.

Here's a quick look at other highlights of the Journal's annual refining survey:

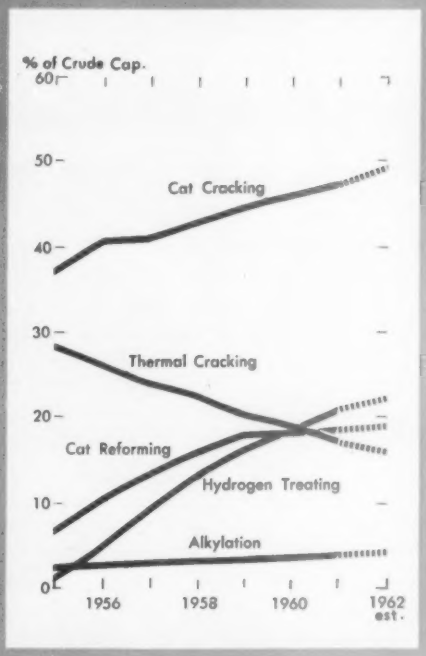
... **Cat cracking** pushed above 5,000,000 bbl. per day during 1960 as 215,000 bbl. were added to total feed capacity. Last year's percentage gain of 4.5% will be equalled this year as 221,000 bbl. are slated to come on stream.

... **Hydrogen treating** spurted upward again as it has every year since the process was introduced in 1954. Capacity now tops 2,218,000 bbl. per stream day. The percentage gain of 14.3% during 1960, as well as the capacity gain of 277,000 bbl., was the largest for any refining process. Another big increase of 136,000 bbl. is on the books for this year.

... **Catalytic reforming** is barely holding its own. At 1,963,000 bbl., this process accounts for 18.7% of crude capacity. The trend has remained the same for several years. On January 1, 1960, it was 18.5% of crude capacity. In 1959, it was

The JOURNAL Report on

Downstream Processing



Cat cracking: Increase continues.

(Total feed capacity, BPSD)

Type	1-1-59	1-1-60	% recy.	1-1-61	% recy.	(Est.) 1-1-62
Fluid	3,482,570	3,697,975	26.5	3,900,456	27.3	4,128,456
T.C.C.	741,900	755,580	30.3	795,620	29.0	795,620
Houdriflow	255,400	255,360	22.4	254,555	29.0	254,555
Houdry F. B.	76,300	76,755	27.3	61,755	30.4	61,755
Cycloversion	11,690	13,560	...	1,900	...	1,900
Total	4,567,860	4,799,230	27.3	5,014,286	27.9	5,242,286

Cat reforming: Barely holding own.

(Feed capacity, BPSD)

Type	1-1-59	1-1-60	1-1-61	(Est.) 1-1-62
Platforming	907,835	988,400	1,014,615	1,047,415
Ultraforming	247,390	247,990	248,490	248,490
Sinclair-Baker	145,400	152,300	184,150	184,150
Mobil	123,400	126,935	146,450	146,450
Houdriforming	139,560	140,409	140,409	148,909
Powerforming	67,500	64,500	70,500	70,500
Catforming	55,600	55,500	55,500	55,500
Fluid Hydroforming	62,600	60,800	33,000	33,000
Rexforming	26,200	17,000	11,500	11,500
F. B. Hydroforming	19,000	5,000	5,000	5,000
Misc.	54,400	53,000	53,600	65,600
Total	1,848,885	1,912,834	1,963,214	2,016,514

18.2%. Projects contracted for this year will increase capacity by 53,500 bbl. per day; thus the percentage figure will improve somewhat.

...Alkylation is maintaining a steady but unspectacular growth. Capacity now stands at 425,000 bbl. per day, an increase of 17,700 bbl. and a percentage gain of 4.4% over January 1960. New capacity slated for 1961 completion will boost the total by only 13,500 bbl.

Outlook . . . The year 1961 is going to see more activity on the construction front than either 1960 or 1959. But it won't have to go far to beat either of those two. Indications are that capital spending will be about $468 million this year, compared with $367 million in 1960.

Although part of this year's expenditures will go to replace marginal, uneconomical capacity, a substantial part of it will be used for additions to capacity. Cat cracking and hydrogen treating will get the biggest outlays.

Because of the increase in construction, the cushion in refining capacity will likely see little change.

It's difficult to tell how much of the cushion is marginal—and there's no reasonable basis for a projection of how much capacity will be retired during the coming year.

All of the old reliable barometers, however, show that the picture is going to remain about the same.

Here's why:

Historically, predictions of capacity which are based on construction activity are conservative. For instance, construction projects committed on January 1, 1960 showed that net additions to crude capacity would be about 62,700 bbl. Actually, 144,000 bbl. were added last year.

Construction committed this year shows that capacity will increase 73,000 bbl. by January 1, 1962. If past performance is any indication, crude runs will hit 8,124,000 bbl. per day this year.

With a capacity increase of only 73,000 bbl., the cushion will still remain about the same—81.5%. If, however, actual capacity is double that which is now committed—as it has in years past—the unused cushion will be even greater.

Breakdown . . . A brief rundown on some other aspects of the survey:

...Thermal cracking. Capacity tumbled again last year. It's been decreasing steadily since 1948, although coking and visbreaking continue to find favor. New cokers will be added this year as refiners seek to convert residual stocks, but this probably will not be enough to take up the slack caused by the scrap-

Reprints Available

THE JOURNAL'S new plant-by-plant survey and construction report, starting on page 164, will be available in reprint form at $2 per copy.

Address your requests to Reader Service Department, The Oil and Gas Journal, Box 1260, Tulsa, Okla.

Hydrogen treating: Shoots up again.

By process type (BPSD)	1-1-58	1-1-59	1-1-60	1-1-61	(Est.) 1-1-62
Unifining	498,605	641,505	696,595	679,385	721,785
Mobil	99,260	149,900	142,195	223,300	223,300
Ultrafining (Ind.)	187,600	216,100	218,100	210,700	218,200
Hydrofining (Esso)	164,900	165,700	187,100	202,320	202,320
Shell	70,700	104,900	140,500	201,000	233,500
Hydrobon		55,000	119,000	119,000	119,000
Sinclair	87,500	99,000	125,000	115,500	123,100
Gulfining	100,000	100,000	100,000	100,000	100,000
Standard (Ohio)		22,500	22,500	33,500	33,500
Richfield	8,000			32,000	32,000
Ashland	29,000	30,000	30,000	30,000	44,000
Continental	16,000	17,700	28,700	29,000	29,000
Houdry	13,960	22,110	14,650	25,104	25,104
Kellogg	20,000	20,000	20,000	20,000	20,000
Other (own)	47,200	39,000	64,550	197,750	229,750
Total	1,342,725	1,713,415	1,941,390	2,218,559	2,354,559

Type of Feed

By feed type (BPSD)	1-1-61	(Est.) 1-1-62
S.R. Naphtha	1,428,664	1,505,164
Mid. Dist.	547,710	586,710
Cracked Naph.	73,000	78,000
Lubes	36,860	49,860
Cat. Feed	22,245	24,745
Solvent Naph.	10,000	10,000
Wax	5,360	5,360
Cat Recycle	1,200	1,200
Undefined	93,520	93,520

Alkylation: Growing steadily.

(Product capacity, BPSD)

	H_2SO_4	HF	Total
January 1, 1957	212,659	59,960	272,619
January 1, 1958	244,615	65,750	310,356
January 1, 1959	290,400	79,720	370,120
January 1, 1960	311,280	96,145	407,425
% crude	3.01	0.93	3.93
January 1, 1961	323,405	101,686	425,091
% crude	3.08	0.97	4.05
January 1, 1962 (est.)	335,705	108,886	444,591

ping of other obsolete thermal processes.

Coking capacity now stands at 436,200 bbl. per day. Of the 36,000 bbl. slated to come on stream this year, 32,000 bbl. will be installed on the Texas Gulf Coast. This area, at 7.6%, already has one of the lowest residual yields in the country.

... Hydrogen processing. Catalytic hydrocracking is beginning to find favor, particularly on the West Coast. A 7,500 and 2,500-bbl. unit are slated for operation this year, while 1962 will see at least two more projects come on stream. In all, this will raise capacity to 52,500 bbl. by 1963.

Processing heavy crude for the most part, California refiners have watched their fuel-oil and residual market dwindle to a shadow. In this type of situation, hydrocracking of middle distillates becomes attractive.

The picture is different for the rest of the country. But if natural gas continues to cut into heating oil markets, this versatile process will find increasing favor there as well.

In most plants, hydrogen is at a premium. And, as hydrogen treating capacity continues to expand, the situation will get worse. More hydrogen is used now than ever before to treat cracked naphtha, middle-distillate products, and to finish lubes. More will be used.

As the need for hydrogen grows, refiners will turn to manufacturing their own. Many have already done so. When hydrogen capacity has to be installed for these reasons, hydrocracking will be more attractive.

... Isom is slow. With octanes moving up very slowly, refiners have found no need to install isomerization capacity. No new units came on stream in 1960 and none is expected in 1961. Capacity remains at 51,000 bbl. per day. Two units are scheduled for completion in 1962 which will increase capacity by 8,800 bbl.

The slight octane increase over last year is being met for the most part by operating the reformer at a higher severity.

Independents decline . . . Although the number of independent companies increased during 1960, their share of the nation's crude capacity has dropped slightly.

The majors continue their lead in the level of catalytic processing, but it's not a commanding lead. And the independent's position is better than the figures indicate. Some plants have no distillate production, yet they account for almost 500,000 bbl. of crude capacity. When this is taken into account, the independents compete favorably.

Independents brought several plants on stream during 1960 and one more is scheduled to begin operation this year.

Debco Corp. of Texas brought a 750-bbl. plant on stream at Abilene and Upper Peninsula Oil Refineries, Inc., began operating its 1,500-bbl. plant at Rapid River, Mich. In addition, Plateau, Inc., reopened a 2,500-bbl. plant at Bloomfield. N. M.

Great Western Refining Co. is reopening a 4,000-bbl. refinery at Dickinson, N. D., and plans to be on stream by July 1.

How the Majors and Independents Stand

	Companies controlling over 100,000 bbl. daily capacity			Companies controlling less than 100,000 bbl. daily capacity		
	1-1-60	1-1-61	1-1-62*	1-1-60	1-1-61	1-1-62*
	(Capacities in 1,000 BPSD except where noted)†					
No. Companies	21	21	21	137	141	141
No. Refineries	123	125	125	171	173	171
Capacity, BPCD	7,996.1	8,137.9	8,205.8‡	1,793.3	1,795.8	1,800.6
Capacity, BPSD	8,413.6	8,592.1	8,660.6	1,947.4	1,907.7	1,912.7
Annual change, %	+3.6	+1.8	+0.8	−4.4	+0.2	+0.3
% of U. S. total	81.2	81.9	82.0	18.8	18.1	18.0
Cat. cracking	4,106.1	4,305.3	4,482.3	693.1	709.0	753.0
% on crude	48.8	50.1	51.8	35.6	37.2	39.4
Hydro. treating	1,690.8	1,956.5	2,067.3	250.6	262.1	287.3
% on crude	20.1	22.8	23.9	12.9	13.7	15.0
Cat. reforming	1,615.2	1665.3	1,704.5	297.6	297.9	312.0
% on crude	19.2	19.4	19.7	15.3	15.6	16.3
Alkylation	358.5	365.2	375.0	48.9	59.9	63.6
% on crude	4.3	4.3	4.3	2.5	3.1	3.3

*Estimate based on construction slated for 1961 completion only. †Includes plants charging whole crude only. ‡Includes acquisition of Douglas Oil Co. of California by Continental Oil Co.

Refiners With Over 100,000 Bbl. capacity

Rank	No. Refineries	Capacity (BPCD)
1. Humble	8	961,440
2. Texaco	14	739,000
3. American	12	738,400
4. Mobil	12	716,700
5. Standard (Calif.)	12	685,500
6. Shell	6	594,000
7. Gulf	5	562,557
8. Sinclair	6	489,000
9. Cities Service	4	292,300
10. Tidewater	3	280,500
11. Phillips	6	274,300
12. Sun	2	255,000
13. Atlantic	2	210,000
14. Continental	7	194,200
15. Union	6	188,800
16. Pure	4	185,500
17. Standard (Ohio)	4	170,500
18. Sunray	3	170,250
19. Richfield	1	165,000
20. Ashland	5	157,700
21. Ohio	3	107,300

Among the majors, Standard Oil Co. of California brought its 32,000-bbl. plant at Honolulu on stream last year. And Gulf Oil Corp. took over operation of Wilshire Oil Co. of California's 32,000-bbl. refinery at Santa Fe Springs.

There are shutdowns too. Texaco Inc. is closing its asphalt plants at Claymont, Del., Sunburst, Mont., and Providence, R. I., this year.

Canadian developments . . . The rash of expansion which has marked the Canadian industry for the past several years is coming to an abrupt halt. Although capacity soared during 1960, construction of crude capacity will dwindle this year to 6,200 bbl.

Downstream construction will fare only slightly better. Only five projects are on the drawing boards for 1961 completion.

Canadians have little need to increase capacity, however. They have plenty to spare, particularly in the Atlantic provinces. Two new refineries completed there last year have contributed to an already overcrowded market place.

Crude capacity now stands at 948,730 bbl. per day, up 103,900 bbl. or 12.3% over January 1960. The increases slated this year will boost the total by only 0.07%.

Canadian refiners continue to maintain a high level of catalytic processing. In hydrogen treating, they surpass the U. S. in the percentage of the crude barrel processed. The ratio is 24.2% compared to 21.1% in the U. S.

Alkylation capacity soared 141% during 1960, but this was in comparison with a small base. The process topped 13,400 bbl., but it accounts for only 1.3% of crude capacity. In the U. S. the same ratio is 4.0%. No new units are slated this year.

Cat cracking last year moved up to 439,000 bbl. per day of total feed for an increase of 14.9%. Capacity slated to come on stream will boost this total to 455,000 bbl. by the end of 1961.

Cat reforming, up 174,000 bbl. as of January 1, will see little growth this year. No new units are sched-

The Journal Forecast of Canadian Refining

Capacity	Crude		Feed, BPSD					Product, BPSD	
	BPCD	BPSD	Vacuum	Thermal Cracking	Catalytic Cracking	Cat Reforming	Hydrogen Treating	Alkylation	Polymerization
Jan. 1, 1960	844,830	920,020	332,430	90,680	382,060	150,610	183,395	5,570	18,215
Jan. 1, 1961	948,730	1,009,195	405,405	94,585	439,205	174,430	244,960	13,445	26,872
Per cent change	12.3	9.7	22.0	4.3	14.9	15.8	33.6	141.1	47.3
Jan. 1, 1962 (est).	954,905	1,015,695	405,405	94,585	455,205	174,430	251,560	13,445	26,872
Construction									
1961	6,175	6,500	0	0	16,000	0	6,600	0	0

uled. This versatile process for gaining octanes now accounts for 17.2% of the Canadian crude barrel.

With so little construction in the works, demand may have a chance to catch up somewhat this year. Like the U. S., Canada was caught in a postwar building boom that outstripped demand. And it's going to take a few years to close the gap.

Survey data . . . Figures in this report are based on plant-by-plant capacity data given to the Journal by operating refiners.

A detailed survey—the only one of its kind—starts on page 164.

Included in this survey are all facilities which were operating at the first of this year. It is restricted to plants charging whole crude oil. An appendix covers specialty plants processing petroleum or related fractions to produce lubes, waxes, and fuels.

It is recognized that a survey of refineries does not include all sources of gasoline. Numerous gas-processing plants produce blends or finished motor fuel, but are not included because they are not classed as refineries.

To arrive at consistent totals, calendar-day totals have been converted to a stream-day basis. They are divided by 0.95 in the case of crude and vacuum units and 0.90 in other processes.

The Journal makes no effort to pinpoint forecasts of capacity. However, it does include a listing on page 189 of all new construction planned at the first of the year. These net additions to capacity have proved reasonably accurate in projecting over a 1-year period, but they do not take into account upgrading, removal of bottlenecks, unscheduled shutdown, retirement, or downgrading of capacity which may occur during 1961.

Continental Joins Pauley in Mexican Program

- Half interest in Bay of Campeche holdings involved in $8-million deal.

Two more drilling platforms and 20 to 25 wells to be added this year.

CONTINENTAL Oil Co. has joined Pauley Petroleum, Inc., as a 50-50 partner in Pauley's Mexican tidelands operations in the Bay of Campeche.

Continental paid $8 million for half interest in the tidelands holdings where Santa Ana field is being developed.

The field currently has eight completed wells capable of producing 10,000 bbl. daily. One well is a single completion, five are dual completions, and two are triple completions. The wells can make 500 bbl. daily per zone through a ¼-in. choke.

Pauley mapped a major development program for Santa Ana, but needed a partner to help finance the drillings at the pace set up in the program. Continental will provide the new funds.

At the same time, Continental may also get a new source of crude for either its Gulf Coast refining operations or possibly for a refinery the company is building in Panama.

Santa Ana drilling . . . The development program in Santa Ana includes increasing production, drilling, and pipeline capacity.

Here's what is planned in the offshore field:

. . . Two more permanent offshore platforms will be added.

Currently, one 12-well platform is being used to develop the field. A second platform with a capacity of 16 wells will be completed in July and plans are being made to add a third platform with a capacity of either 16 or 24 wells.

. . . A new drilling schedule calls for a well to be completed every 30 to 35 days. An estimated 20 to 25 wells will be completed this year.

Pauley, which will continue as operator through a subsidiary, Pauley Pan American Petroleum Corp., also plans to do some core drilling from one or two mobile platforms. A Mexican drilling contractor, Permargo, is handling the drilling.

. . . A second pipeline with a daily capacity of 35,000 bbl. is being laid from the field.

Current production in the field is restricted to 5,300 bbl. daily due to pipeline capacity, but this will be increased to 40,300 bbl. daily when the new line is completed in 45 to 60 days.

. . . Production in the field is expected to increase as new wells are completed and to reach the pipeline's capacity when the current drilling is completed.

The Santa Ana wells are drilled to about 10,000 ft. to Miocene sands. Pauley reports the field has a strong water drive and is believed to be a salt-dome structure similar to those found in the tidelands off Louisiana.

The eight wells now producing are flowing from seven different zones. One well in the field has found 10 distinctive pay sands with a total pay section of almost 500 ft. All wells are expected to be completed as either dual or triple completions.

Pauley's contract . . . Petroleos Mexicanos is buying Santa Ana output at a posted price of $2.20 for the 31°-gravity crude.

Pemex currently is taking crude from the field and moving it to the 85,000-bbl. Minatitlan refinery. Pauley's contract with the Mexican oil agency guarantees the operator a minimum market of 25,000 bbl. daily.

Pauley's contract covering Campeche also stipulates the company can earn a profit of 18¼% of the value of oil and gas produced and that the company can recover all expenditures, including unproductive costs. The contract runs until Mar. 6, 1974.

Pauley has two other contracts covering other areas of Mexico, but neither is affected by the Continental deal. Lomitas gas field is located in one of these areas and Pauley is selling 50,000 M.c.f. of gas daily to Texas Eastern Gas Transmission Co. This take is scheduled to go up to 68,000 M.c.f. in the near future, based on new reserve figures for the area.

Turnkey Drilling Rises Despite Contractor

Ed McGhee
Drilling Editor
and
Robert Enright
District Editor

A MAJOR company saved $1 million in drilling costs last year in its West Texas-New Mexico division alone by relying on turnkey contracts instead of normal footage contracts.

The lure of that kind of savings is fueling the growth in turnkey wells despite opposition and resentment from many drilling contractors. Chief complaint of most drilling executives is that returns on a turnkey job nowhere balance the big risks they are forced to assume.

Contractors, however, continue to bid in larger numbers on turnkey contracts offered by the operator. And it's easy to see why operators like the method of doing business when the experience of savings is examined.

The firm that saved $1 million last year says it paid an average of 75 cents per foot less for drilling in 1960 than in 1959 and about $1.40 per foot less than in 1958. Although rates on straight footage contracts also dropped some, company officials estimate that at least half of the savings was a direct result of turnkey work.

The company drills more than 200 wells annually in the West Texas-New Mexico division. Two-thirds of its 1960 drilling program was turnkey work. Only one-third of the 1959 program was on turnkey contract, and it was used on none in 1958.

As a result of its experience, the company makes this comment: Savings were substantial. Mechanical quality of holes was satisfactory. Contractors fulfilled their obligations in every way. The company plans to rely heavily on turnkey jobs in the future.

Savings . . . Other major companies also admit savings from turnkey work, although not so spectacular.

A few operators doubt that the savings really are substantial, and most contractors take a dim view on this issue.

Says a contractor, "These majors are attempting to get people off their payrolls so they won't have all the expense of salary and fringe benefits."

One operator admits this is partly true. His company, by relying on turnkey contracts, can eliminate several supervisors formerly used on road building, in running casing or calling on logging and cementing companies. This represents savings of $1,000 to $1,500 per month per man in salary and expenses.

Savings also are realized in accounting and auditing costs. A huge stack of invoices formerly was received for each well. Now, just three or four come in. There also is a bonus in this for the contractor because now he is getting paid much faster.

Other operators contend savings are possible for both the operator and contractor under a turnkey job. The contractor can cut corners, try new methods, feel free to manage the operation as he sees fit.

One example cited is water. When the contractor is furnishing water on a turnkey deal, one operator says, you likely will see a little "yellow dog" down on the pits pumping water back for reuse after it settles. When the operator pays for it, the rig crew will go to the reserve tank for water.

Mud savings are cited by another operator favoring turnkey jobs. The company previously felt that it had to use an expensive high-viscosity, low-water-loss mud to do the job. The drilling contractor on a turnkey job gambled on something cheaper and made it work. Average mud bill in the area now is about $1,270 while 2 years ago it was $2,150.

Sins of operators . . . Contractors who oppose turnkey work claim any savings realized by the operators really come out of the contractors' pockets.

Many contractors feel turnkey jobs are ruinous because companies:

. . . Encourage below-cost bids that often wreck the contractor.

. . . Ask for turnkey jobs in areas where there is too little experience for the contractor accurately to estimate his costs.

What the Industry Thinks

The operators say it:

- Saves companies money by
  - . . . cheaper drilling rates.
  - . . . requiring less supervisory manpower.
  - . . . less accounting and paperwork.
- Saves the contractor money by allowing him:
  - . . . To cut corners wherever possible.
  - . . . To try new methods.
  - . . . To manage the project as he sees fit.
- Ties down the cost of a well which is particularly desirable for multi-owner deals.

. . . Try to saddle the contractor with completion and other work that varies widely in both time and service-company expense.

. . . Broadcast bid requests to entirely too many contractors.

. . . Delay payment too long.

. . . Accept bids from incompetent or financially unstable firms.

It's true that most turnkey-contract prices are too low. But it's because contractors bid too low due

Simpler Drilling

CLAMOR in the industry for a standard drilling contract—one that is practical and as simple as possible—continues to grow.

But despite much lip service by operators and some work by a few associations, the actual trend in contracting appears to be in the opposite direction.

Spurred by the cost-cutting urge, operators are churning out more varied and lengthy contracts with more and more clauses.

And contractors are chafing. Latest to speak out was Robert L. Parker, president of Parker Drilling Co., Tulsa, who spoke at the southwestern district meeting of the API Division of Production.

Present-day types of contracts

Opposition

of Turnkey Drilling

The contractors say it:

- Encourages reckless bidding which lowers prices.
- Imposes risks on contractor that he shouldn't bear alone.
- Opens the door to abuse by operators who often:
  - . . . Ask for contracts in areas where conditions are unknown.
  - . . . Saddle the contractor with too many obligations.
  - . . . Ask too many contractors to bid and then accept bids from incompetent or financially unstable firm.
  - . . . Delay payment too long.

to competition stemming from an oversupply of rigs in the area.

Often the low bid comes from a contracting firm already in financial trouble. The contractor wants the job to bring in revenue for current expenses. He ignores rig depreciation in figuring the bid, hoping conditions will improve as time goes on.

The turnkey contract apparently encourages more of this kind of risky bidding than straight footage contracts. The contractor has more freedom to cut corners and chop his own costs. Also the money flows in quicker than under other contracts.

The risk naturally is that if something goes wrong—like a lost hole, a fishing job, a breakdown—the contractor will suffer the loss that will throw him out of business.

Not all oil operators have been guilty of gouging practices, and some have taken steps to avoid them.

One major states that in West Texas-New Mexico it seldom asks for bids from more than six contractors. Its turnkey contracts, the company believes, have just as many safeguards for the contractors as do footage contracts. Company officials say contractors working for the firm take turnkey contracts frequently and like this method of doing business.

At least two major companies have begun auditing the records of its drilling contractors in the area. Although understandably reluctant to comment, company management apparently has become concerned about the risk involved in awarding contracts to firms on the verge of bankruptcy.

The division drilling superintendent for one active major says: "Some contractors scream bloody murder when the word turnkey is mentioned. We think they are misguided to some extent. Or, at least, their definition of 'turnkey' and ours differ.

"We require the contractor to build the road (with an upper limit on cost), furnish one log, drill to total depth, run and cement pipe, dress the plug, and circulate the mud out of the casing. Then, the rig goes on daywork.

"Some companies are turnkeying wells in West Texas where the contractor pays for and does the perforating, fracturing or other stimulation, squeezes to isolate zones, etc. This can get the contractors into a mess. And, they don't like it. I think this is the sort of thing that has given turnkeying in general a bad name.

"Our company's turnkey contract even has a lost-circulation clause in it. The contractor goes on daywork when circulation is lost either 24 consecutive hours or after a cumulative total of 72 hours. That's about as much protection as they have on a footage contract."

Some less considerate . . . While some oil companies display an understanding of the contractors' problems, others do not. This fact is creating genuine alarm in many contracting offices.

"Why just last week," says a medium-sized Midland, Tex., contractor, "I got a request to bid on a turnkey well way out in the Dela-

Contracts Urged, But Trend Heads the Other Way

have dealt a severe blow to progress of the drilling industry, Parker said. "It is imperative for a successful future in drilling wells . . . that a more sensible, simple, and practical contract be developed."

Parker criticized a trend which finds contractors drilling for lawyers rather than company drilling personnel. He quoted a major oil-company executive as saying recently that: "Present drilling-contract forms are legal requirements that have replaced practical production-department contracts. Legal clauses that were added as stop gaps are now applied as the rule."

Asking too much? . . . Operators, Parker said, have gone overboard in demanding that the contractor furnish more and more equipment, assume more hazardous risks, and furnish more fringe benefits—all at the same old price.

"Equipment requirements," Parker said, "have become almost fantastic because they can be written in by the operator at the same price. And it is not a part of the business for the contractor to assume hazards in drilling a well over which he has no control—such as blowouts and lost circulation."

Elimination of the lost-circulation and/or blowout clauses is the "greatest of all misuses of the drilling contract."

Parker said it is not uncommon on some wells for a contractor to invest $250,000 in blowout-preventor equipment and on the next well find it is unsatisfactory to the operator.

Parker strongly urged operators to work harder for a "practical standard blowout preventer and choke assembly" which would encourage contractors to invest in such equipment.

Better balanced rigs . . . On the brighter side. Parker noted an apparent trend among both operators and contractors to use better balanced drilling rigs.

And equipment requirements, he said, seem to be becoming more practical with less demands made for maximum equipment.

ware basin. The nearest well of any kind was an old cable-tool hole 26 miles away! How can you make any meaningful estimate of costs with no better control than that? And, I'll bet more than a dozen contractors were asked to bid on that hole."

An Odessa, Tex., contractor pulls a supply-house invoice from his desk drawer to make a point about oil company abuses on turnkey contracts. "At the bottom of every invoice we get is a statement that payment is due 30 days after billing. Past that, we begin to owe the supply house 7% interest," he says. "Many times, the oil companies don't pay us that soon, so we have to charge them the 7% too. And the funny thing is that they can probably get most of this stuff cheaper than we can anyway."

The West Texas division manager for a large contractor figures that it costs his company something over $50 to figure every bid. "A lot of the operating companies have made a practice of sending out 15 or 20 bid requests. We have to submit a bid on almost all of them as a matter of courtesy; so does everyone else. So, on every well, the operator may be costing his contractors $1,000 for bids alone. And, make no mistake about it, the operator winds up paying that $1,000 in the end."

The outlook... With so much sentiment against the turnkey contract, it might appear that only firms near bankruptcy take such jobs.

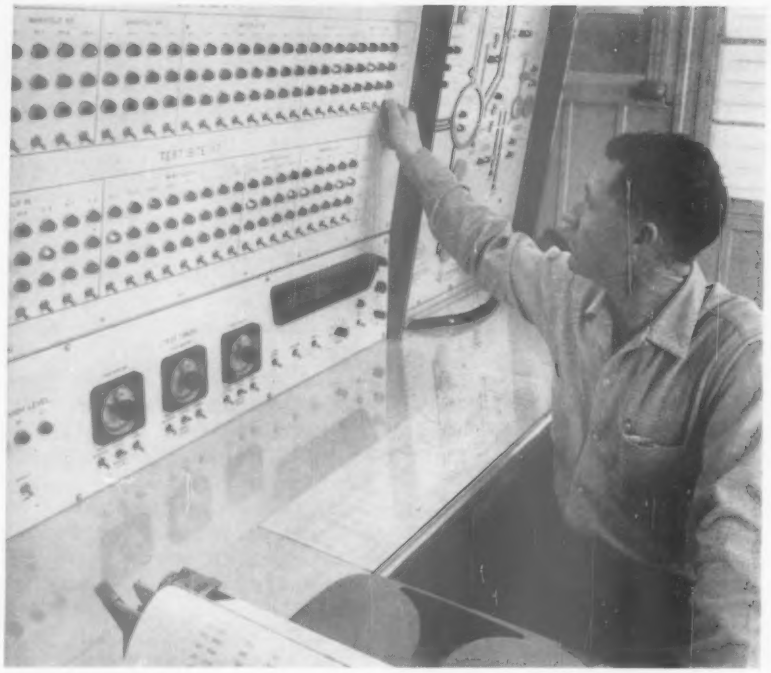
This isn't the case, of course.

Contractors have taken turnkey jobs for years for small independents. Often these jobs involve several different companies or individuals who want drilling cost tied down.

And now that the major companies are letting turnkey jobs, almost all contractors take such work periodically. Some actively seek it.

One contractor predicts, "We might as well get used to it—it's the coming thing."

Another observes almost prayerfully: "The day will surely come when the supply of rigs is more in balance with demand—when we'll have a sellers' market. When we do, you can be sure of one thing. We'll either include a realistic risk factor in our bid or else we'll not bid at all on turnkey jobs."



Dial System Runs Oil Project

- Mobil's having great success with its new "long-distance" electronic monitor in West Texas field.

MOBIL Oil Co. is reducing button-pushing to a fine art in West Texas' huge Kelly-Snyder field.

It has installed an automatic system for producing and gathering oil in Segment 2 of the sprawling SACROC unit pressure-maintenance project in Scurry County.

Now a Mobil operator can shut down, start up, or test 50 wells in a 3,400-acre area simply by dialing a number on a central electronic-control panel. He can handle the wells individually or automatically in sequence.

All test and production data—complete with well number, time, and date—are automatically printed at the control center, furnishing a complete and permanent record.

Above, Mobil's N. E. Bourland, engineering supervisor, demonstrates the procedure.

Current production from the automated portion of Segment 2 is more than 79,000 bbl. per month.

A central console, connected by telephone lines to 11 remote field stations, enables one man to monitor:

... **Automatic custody transfer** of oil from the lease to the pipe line.

... **Operation** of all central tank-battery equipment.

... **Changes in status** of any well.

... **Oil-production** volumes.

The system already has enabled Mobil to reduce maintenance and operational costs. The number of tank batteries in the 3,400-acre area has been cut from 13 to one.

Control of producing wells is faster and more complete. And the company is recovering and selling more petroleum gases.

Further analysis of results may lead Mobil to install five similar projects in Segment 2.

A detailed engineering story on the Mobil system will appear in an early issue of the Journal.

FPC grants boosts in gas prices to three Texas areas

THE Federal Power Commission has decided the area prices it set for natural-gas sales by producers in three North Central Texas districts were too low. So it has raised each

by 0.5 cent per thousand cubic feet.

In an amendment to its original area-pricing guide the FPC set a ceiling of 14.5 cents on the initial rate of service in Districts 5, 7-B, and 9. The previous ceiling was 14 cents.

FPC also specified that in Districts 5 and 9 the maximum for increases in old rates would be 14.5 cents instead of 14 cents. In District 7-B, the level for increased rates will be 11.5 cents instead of 11 cents.

All rates are at a pressure base of 14.65 psi.

The adjusted levels "include tax reimbursements, establish the total area price for pipeline-quality gas and appear appropriate and in the public interest," FPC said.

Congressional fuel study favored by new administration

THE Kennedy administration last week committed itself to support congressional action to set up a long-range fuels study.

Interior Secretary Stewart L. Udall announced at the annual dinner of the National Coal Policy Conference in Washington, D. C., that the administration would support pending legislation.

"We can't let policy be set by drift or default," Udall told the coal group.

Udall said what is needed is a long-range, balanced study. He did not indicate whether the administration favors a House or a Senate study, but his announcement seemingly would rule out any study by the administration itself at this time.

Coal representatives applauded when Udall discussed the study. However, one of their own spokesmen had already made clear that this alone will not satisfy coal's wants.

George H. Love, chairman of the NCPC, appearing on the program ahead of Udall, said the coal industry supports a long-range fuels study but that the Government would be urged to act now to reduce residual fuel—oil imports and to prevent the "dumping" of natural gas into industrial markets.

These steps should be taken, he said, without waiting for a fuels policy to be shaped by Congress.

watching WASHINGTON

Clyde La Motte

• Serving your federal Government can be costly . . .

IT MIGHT BE WELL for the Government to take a second look at the practice of requiring a person to dispose of certain holdings to avoid a "conflict-of-interest" charge when he accepts a government position.

As it is now, a citizen can pay a pretty high penalty for the privilege of serving his nation.

Take the case of John M. Kelly, a New Mexico oil and mining man who accepted the position of assistant secretary for minerals in the Interior Department.

To avoid any conflict-of-interest charge, Kelly is selling all his outside stock holdings in oil and mining companies. The federal leases, productive and nonproductive, he owns are being put in a trust to be sold.

Finally, Kelly and his wife are resigning from their family-owned Elk Oil Co., and are making an outright gift of the company to their four children.

The only oil-related holdings that Kelly will retain are his interests in leases of state and private lands.

• Some doubt the wisdom of present requirements . . .

A MEMBER of a Senate committee that held a hearing on Kelly's nomination last week wondered out loud whether this approach toward avoiding any conflict of interest isn't superfluous—if not outright unfair.

He thinks it might be enough to require only that a government official file for public record a statement of his financial interests.

His premise is that if the appointee is a man of integrity, you do not have to worry about abuse. And the public record of a man's holdings would put the spotlight on an official who might be tempted to stray.

There's an old saying that you can't legislate morality. And you can't assure integrity simply by making an official divest himself of any financial connection with an industry over which his government position may give him some responsibility.

• Kelly: "A study might show that 27½% is too low" . . .

KELLY FARED WELL in his appearance before the Senate committee.

When the committee went into executive session to pass on Kelly's nomination, it took only 17 seconds for a unanimous vote of approval.

Kelly will be sworn in this week, after returning from an Easter trip to New Mexico.

Here are some of the views he expressed at the hearing in response to specific questions:

He would, if asked by government policy-makers, favor a thorough study of oil's percentage depletion. He thinks that such a study might well show that 27½% depletion is on the low side, rather than being too high under present conditions.

He is inclined to feel that all federal land leasing should be on a competitive-bid basis.

He is not familiar with the Government's plan to encourage private-industry construction of helium plants, but is aware of the conservation aspects involved.

Export Bank Tells Why It Eased Up on Credit

• Officials say they dropped ban on government-credit backing of equipment sales to oil-monopoly nations in order to give U. S. firms a chance to compete with foreign companies. Move is part of a drive to bolster exporting.

THE Export-Import Bank has spelled out the details of a policy change which will enable U. S. manufacturers of oil-field drilling-and-refinery equipment to obtain government-credit backing on certain foreign sales.

The change affects sales to nations with a government oil monopoly or to a joint government-private industry oil enterprise.

Heretofore, no U. S. Government financing or loan guarantee has been permitted on oil-equipment sales to countries with any form of oil monopoly.

Export-Import bank officials say the change was made to let U. S. firms compete on even terms with equipment manufacturers in other countries.

They saw little point in continuing a credit ban on such sales because an oil-monopoly nation could simply turn to a manufacturer in another country and get the needed equipment.

The old rule, they say, handicapped U. S. suppliers rather than a nationalized oil company.

Also, the bank officials point out, the new move is part of over-all efforts to help make sure that U. S. exports don't suffer because of a lack of financing facilities.

There has been growing government concern over the gradual decline of many U. S. exports.

The new rule . . . Bank officials emphasize that the rule change affecting oil applies to equipment and not to the oil ventures themselves.

That is, while the bank will grant credit on the sale of oil-field exploration-and-drilling equipment—even including trucks needed by an exploration team — it will not help finance an exploration or drilling project.

Bank officials are somewhat fuzzy in attempting to draw a similar cutoff line on refineries.

They say the bank will help insure financing for the sale of refinery equipment, but indicate it won't back the construction of a refinery.

Also, the bank isn't sure it will back financing of refining processes.

Officials say they won't undertake to insure that a domestic firm will be paid royalties on a refining process, but indicate that if such royalties are made a lump-sum part of the initial sale of the refining equipment, bank-supported financing may be permissible.

How to participate . . . The bank has already opened the door to applications for financing of the sale of equipment to government-owned or government-controlled oil companies abroad.

A bank official says, however, that the processing of such applications probably will take longer at the outset than applications on established programs.

Even so, he indicates that bank action probably won't require more than a very few weeks. (In established programs, loans are sometimes approved within 48 hours.)

Here is how an equipment supplier should proceed if he is interested in getting government backing on a medium-term loan (a loan of up to 5 years is the maximum in this category):

. . . Write a letter to the Export-Import Bank, Washington 25, D. C., and ask either for a loan guarantee on the sale the supplier would make on credit or ask for direct financing.

. . . Go to a commercial bank and ask if it will participate in a no-recourse loan which would be backed by the Export-Import Bank. (The no-recourse feature simply eliminates the supplier from any obligation for repayment of the loan to the foreign buyer.)

There are certain other details involved in such a transaction. Commercial banks are being informed of all phases of the program. Or, additional information may be obtained directly from the Export-Import Bank.

Why the rule was changed . . . Harold Linder, president of the Export-Import Bank, conceded at a press conference that the rule change was made after the bank had received protests from oil-field equipment manufacturers.

He said the bank was told of several cases where U. S. sellers lost big sales to foreign government-controlled oil firms because the former could not extend long-term credit.

The new policy is expected to help equipment sales mainly in Latin America. Most nations there have government-operated exploration and production agencies but do not manufacture oil-field equipment.

The amount of new business which the ruling may generate is hard to estimate, but several members of the Petroleum Equipment Suppliers Association figured last December they were losing anywhere from $100 million to $200 million per year in business for lack of credit support.

Richard White, president of Mission Manufacturing Co. in Houston, says the policy does not mean that American manufacturers will automatically get this new business.

"This simply places us on a more

PIPELINE

Colorado-Wyoming Gas Co. will build a 16.7-mile 16-in. line from its system along Highway 6 to Louisville, Colo. The company also is building a 2-mile 4-in. line from its 4-in. main line to Niwot, Colo.

A 106-mile 12-in. natural-gas line from Minot, N. D., to Bismarck will be built by Montana-Dakota Utilities Co. if FPC gives a go-ahead. Tentative target date for completion is September 1.

Gathering lines totaling 28.2 miles have been completed in the Pembina area of Alberta by Pem-

equal basis with others on credit," White said. "There is still the matter of price. And each transaction is separate—each must stand on its own."

Wallace D. Wilson, president of Wilson Supply Co. and former PESA president, believes manufacturers will be able to do new business abroad under the policy, but much will depend on the terms of the credit support given by the bank.

H. R. Safford, executive vice president of PESA at Houston, says American manufacturers believe they can now compete with foreign manufacturers of oil industry equipment, even if there should be a price differential up to 10%. The reason: "technical superiority."

Deepest Alabama Test Fails

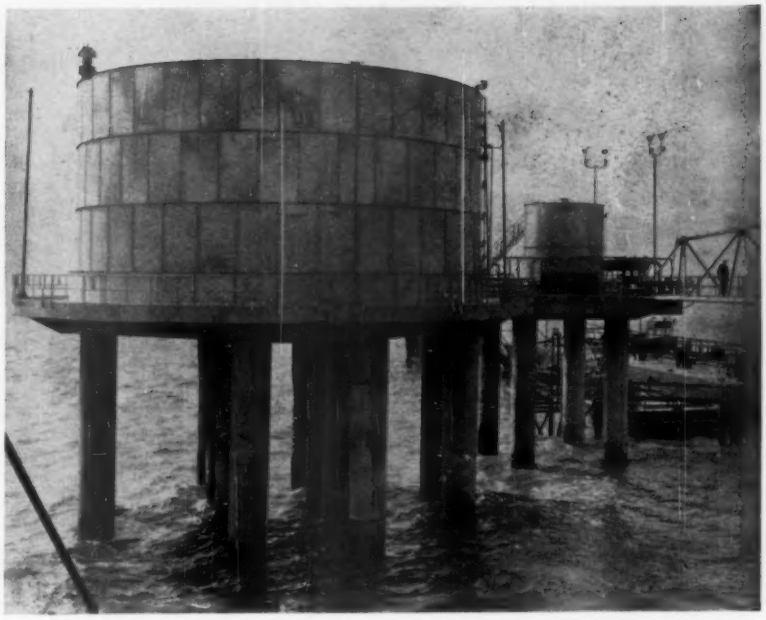
HUNT OIL CO. has plugged and abandoned the deepest well ever drilled in Alabama.

The company gave up on its 1 Tyler Odum in Washington County after logging out at a total depth of 18,716 ft. This was more than 3,000 ft. deeper than the old record-holder which was drilled to 15,659 ft. in 1948.

A Hunt spokesman says there were no worthwhile shows.

The 1 Odum was drilled by Hunt on a 20,000-acre block obtained in a farm-out deal from Seneca Development Co., Dallas.

Location is in Sec. 13-3n-4w, about 1 mile west of Deer Park.



Offshore LACT Goes Big Time

SHELL Oil Co. has just completed offshore Louisiana's largest lease automatic custody transfer (LACT) system.

The huge facilities contain, among other things, a circular pre-cast concrete platform that supports a 10,000-bbl. 70-ft.-diameter surge tank (photo, left) and a smaller platform supporting a 500-bbl. "bad oil" tank (right).

The system meters and checks about 8,500 bbl. of crude and condensate daily from 57 oil wells and four gas-condensate wells in Block 18, Eugene Island field.

By tying the production together, Shell realizes a large savings on barge costs. The crude is barged from the LACT location to Shell's Gibson, La., terminal.

BRIEFS . . .

bina Pipe Line, Ltd. Included are 10.8 miles of 3-in. line, 13 miles of 4-in., and 4.4 miles of 6-in.

A delivery record of 941,500 bbl. per day was set by Service Pipe Line in February. This was an increase of 12,700 bbl. over January.

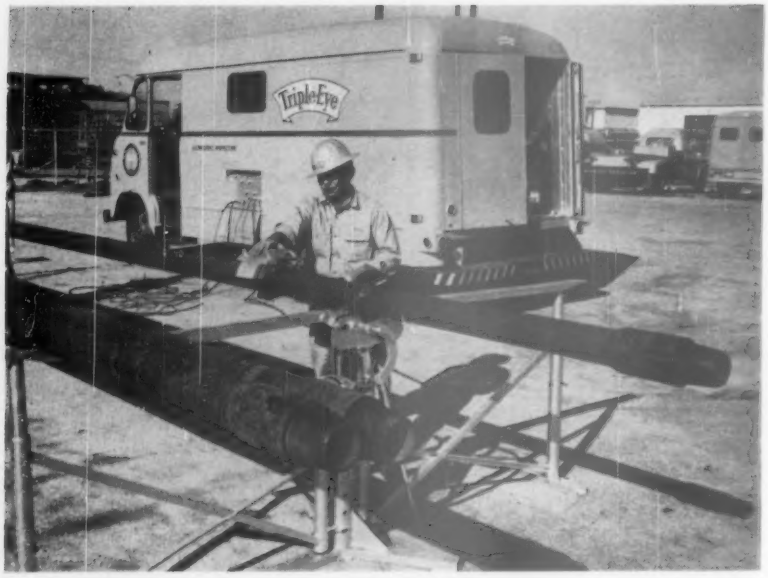
Coating of 33 miles of 20-in. pipe for Trunkline Gas is planned at the Harvey, La., yard of H. C. Price Co. Enamel coating and Hevicote concrete coating will be applied.

Two loops, one of 2.9 miles of 30-in. line from the Delaware River to near Lambertville, N. J., and one of 23.5 miles of 36-in. from Lambertville to the Raritan River, will be completed for Texas Eastern Transmission in May.

Intermediate, unattended relay stations will be added to Service Pipe Line's line from Casper, Wyo., to Freeman, Mo., this spring. Two electric-centrifugal pumping units of 2,500 hp. and 1,500 hp. will be placed in the Abilene, Kans., station on the 24-in. Laton-Freeman section. LaBonte station, 20 miles east of Welch, Wyo., on the Casper-Fort Laramie section, will have a 1,500-hp. unit of the same kind.

Northern Natural's proposal to supply Silver Bay and Twin Harbors, Minn., with natural gas has been approved by the FPC. Construction will include 11.5 miles of 30-in. loop, 63 miles of 16-in. line, and 1.2 miles of 4-in. line, plus 5,400 hp. in compressor capacity. The system also will serve Reserve Mining's taconite plant at Silver Bay.

A hearing on Natural Gas Pipeline Co. of America's plan to install 285 miles of 30-in. loops, 60 miles of 36-in. loops, and 22.5 miles of 8-in. laterals has been set for April 18. The project would cost $52,294,000 and would increase daily capacity of the company's Natural division to 870,000 M.c.f. and its Gulf Coast division to 729,000 M.c.f.



WORKMAN hunts for pipe flaws with new ultrasonic tool.

Sonar Checks Tubular Goods

- **Halliburton subsidiary has new device which finds flaws in pipe, casing, and tubing by measuring wall thickness.**

A NEW TOOL which measures the wall thickness of oil-field tubular goods holds promise of saving the industry some money.

The device checks drill pipe, tubing, and casing to determine fitness for service. Its use can lead to savings either by extending the life of the material or by warning the operator not to put weak material back into the hole.

International Inspection, Inc., a subsidiary of Halliburton Co., is offering the new inspection service.

Basically the tool is the same ultrasonic instrument used by International Inspection to check refinery equipment for corrosion (OGJ, Dec. 19, p. 72). It works on the pulse-echo principle to measure wall thickness and detect corrosion or other flaws in the material being inspected.

The ultrasonic method is the first which measures the actual wall thickness of an entire length of pipe. The tool scans a length of pipe as the latter is rotated. A complete pass can be made within 3 to 5 minutes, depending on the diameter of the pipe.

The tool has been used in California to inspect both drill pipe and tubing which was either headed for the scrap pipe or marked for limited use. In both cases, some of the material was found suitable for unlimited use.

A drilling contractor whose drill pipe was inspected says he is "very encouraged" by the early work with ultrasonics. He says it is too early to tell if the pipe will perform as well as indicated by the inspection, but if it holds up he will save the cost of replacing some lengths considered useless.

Some of the pipe also was upgraded from limited to unlimited use. This also should result in some savings.

International Inspection has come up with a set of drill-pipe standards based on wall thickness. Pipe with a thinnest point of 75% of the original nominal thickness is classified as No. 2, or for unlimited use. If the thinnest point falls between 60% and 75%, the pipe is classified as No. 3, or for limited use. Anything below 60% is scrapped.

The company has two units in the field, one in California and another in West Texas.

Additional units are under construction at Halliburton's Duncan, Okla., shops and are expected to be placed in service at the rate of one a month until all areas are covered.

The service is also scheduled for use in foreign fields.

Big gas-processing plant set by owners of Calgary reserves

TWENTY-EIGHT oil and gas companies which own most of the Calgary field gas reserves have organized a new firm, Petrogas Processing Ltd. of Calgary, to build and operate a central gas-treating and sulfur-recovery plant.

Plant facilities and gathering system will have an initial design capacity of 150,000 M.c.f. daily.

Expected daily production includes 107,000 M.c.f. of residue gas, 2,200 bbl. of stabilized condensate, and 863 long tons of elemental sulfur. Construction costs are expected to be $13 million.

Plans envision exporting residue gas to West Coast markets in the United States and supplying Alberta refineries with condensate.

Contracts for engineering and construction have been let to Ralph M. Parsons Co. of Canada Ltd., Pipe Line Technologists (Alberta) Ltd., and Banister Construction Ltd. Completion is expected in December.

INDUSTRY

April crude allowable for Kansas has been set at 305,000 bbl. daily, or 10,000 below the March figure. An Oklahoma reduction to 17,000 bbl. daily in April from the 19,000-bbl. March allowable represents the state's first cut in 6 months. New Mexico's April allowable of 70 bbl. daily for northwest fields and 35 bbl. for southeast fields is unchanged from the past 3 months.

An order limiting production in the Patrick Draw field of southwestern Wyoming has been made permanent by the state's Oil and Gas Commission. Aimed at cutting down on flaring in the field, the order reduces output of six producers from 30,074 to 21,000 bbl. daily. It will be effective until completion of two natural-gas-processing plants now

Humble Launches Massive Water-Flood Project

HUMBLE Oil & Refining Co. has started water coursing down 10 input wells to kick off the 23,000-acre Midkiff unit water flood in Spraberry trend area field.

It marks the beginning of a $4,500,000 program which should recover roughly 29,000,000 bbl. of additional oil from the tight Spraberry sand—nearly three times the 10,700,000 bbl. the unit area has produced to date.

Eventually, the program will be expanded to a point where 73 wells will be taking water and 235 will be producing oil under full flood.

In preparing for the flood, Humble has kept two rotary rigs and several workover rigs busy for about 3 months. Ten new producers and two inputs were drilled. Eight producers were converted to input service and several others to water-supply wells.

The unit injection plant, on the Midkiff Ranch in the northern portion of the unit, is using two 288-hp. pumps to inject 10,000 bbl. of water from the shallower Santa Rosa formation in the field.

The pumps are capable of handling 78,000 bbl. daily at an input pressure of 300 psi., or roughly 40,000 bbl. daily at 600 psi. If need be, Humble is prepared to install a high-pressure pump which would raise discharge pressure to 1,750 psi.

Water from the plant reaches input wells through a 48-mile network of cement-lined pipe. The gathering system consists of 17 miles of asbestos-cement lines. Water at the injection plant flows through two 1,000-bbl. surge tanks.

The unit area now is producing about 55,000 bbl. a month. Production is not expected to increase greatly for some time.

Fill-up is expected to take a year or more in the area now under flood. And it probably will be 2 years before production over the entire unit is affected, according to Humble's W. H. Crow, district engineering supervisor.

All told, 70 working-interest owners and 750 royalty-interest holders are represented in the Midkiff unit.

Principal working interests are owned by Humble, Sinclair Oil & Gas Co., Mobil Oil Co., Texas National Petroleum Co., Union Oil Co. of California, James H. Vandenbark, and Connally Oil Co.

Huge flood area . . . The Midkiff flood operated by Humble is the third flood approved by the Railroad Commission for Spraberry. Altogether about 90,000 acres will be brought under flood by the three projects.

The other two are a 55,000-acre flood operated by Sohio Petroleum Co. in the Driver or east central part of the field (the world's biggest single unit), and a 16,000-acre flood operated by Southland Royalty Co. in the Aldwell area.

This is small potatoes compared with what's to come. Nine other units are either in the discussion or planning stage. They would boost total Spraberry flooding to near the 300,000-acre mark.

Louisiana Sale April 20

LOUISIANA will offer 175 offshore and onshore tracts for oil and gas leasing at its first sale of the year on April 20.

The tracts cover 230,000 acres, half of which are located in the 42 offshore tracts. All the offshore tracts are in the state-controlled Zone 1 near the Louisiana shore.

The State Mineral Board will conduct the sale at 10 a. m. at its offices in Baton Rouge.

BRIEFS . . .

being built by Union Pacific Railroad and the Colorado Oil and Gas Co.

Sale of Woods Petroleum of Canada, Ltd., affiliated with Woods Petroleum Corp., Oklahoma City, has been announced. Included are the Canadian company's 30,000 acres of leases in Saskatchewan and Alberta and all other assets.

Ohio marketing facilities of Humble Oil have been expanded through acquisition of the assets of Sun Flash Oil. Sun Flash has seven large service stations in Columbus and one each in Chillicothe, Lorain, Portsmouth, Warren, and Zanesville. For the time being, Humble will continue sales under the Sun Flash brand.

Agreement for sale of the assets of Merit Oil Ltd. to Canadian Oil Ltd., Calgary, has been completed. Included are Merit's interests in four producing oil wells and certain leases as well as all issued shares of Provincial Products Pipelines Ltd., whose application to build a gathering system for natural-gas liquids is pending before the Alberta Oil and Gas Conservation Board.

In an $18-million deal, Producing Properties, Inc., Dallas, has acquired all of the oil and gas properties of Shoreline Petroleum Corp., San Antonio. The transaction includes 260 net oil and gas wells in eight states, plus about 55,000 acres of undeveloped leases.

Merger of Kutz Canon Oil & Gas Co., Denver, into King Oil, Inc., Wichita Falls, Tex., has been approved by directors of both companies subject to an okay by stockholders in voting set for April 28.

Purchase of 259,292 shares of Macmillan Petroleum Corp. by Founders Corp., a New York investing company, gives the latter about 25% of the 1,039,830 Macmillan shares outstanding. Macmillan, which has headquarters in Los Angeles, has refineries in Long Beach, Calif., and in Norphlet, Ark.

Mining of a propane-storage cavern for Solar Gas (Minnesota), Inc., on a highway between Mentor and Erskine is in the works. The storage facility, which will have a capacity of 300,000 bbl., will be mined at a depth below 500 ft. by Fenix & Scisson, Inc., of Tulsa. Completion is expected by the spring of 1962.

Shrinking Octane Spread May Cost Motorists

Gene T. Kinney
East Coast Editor

TWO IMPORTANT and costly trends in gasoline worry refiners.

They are:

. . . The narrowing spread between regular and premium in octane and other characteristics.

. . . The declining premium sales ratio, caused largely by the first trend.

If both trends continue, as they are expected to do, it could cost motorists (or refiners) an extra $450 million per year. This estimate is based on the premise that a large body of regular-gasoline users will pay for octanes they do not need.

These trends in 1959 cost an estimated $75 million—$30 million was paid by the motorist for the increased regular octane and the cut in premium sales cost refiners $45 million.

Octane spread narrows . . . Regular gasoline is continuing the sharp increase that both regular and premium experienced during the octane race of the 1950's.

During the past 2 years, regular has increased from 91.3 Research Octane Number (RON) to 92.5, the average for 1960. According to the Ethyl Corp. survey in January, regular started 1961 at 92.6, higher than the premium octane as recently as 1953.

During the same 2-year period, premium has only increased from 98.6 to 99.3 RON. So the spread between the two grades has shrunk from 7.3 to 6.8. And the January spread was only 6.7.

Detroit's economy kick continues to put abnormal pressure on regular gasoline. Only 25% of last year's new cars were designed for premium compared to more than 50% in 1958.

Auto designers are using every last regular octane available, and then some. Only 60% of the 1960 models "designed" for regular would operate at trace-knock level on the national - average regular of 92.5 RON.

Thus regular octanes are being pulled up further, leaving still less incentive for car manufacturers to design for premium. Meanwhile the premium octane has leveled off as designers have paused in their upward push on the highest compression ratios.

Premium sales drop . . . Last year, under the influence of the narrowed premium - regular gap and other factors, the premium sales ratio made its biggest drop since 1950.

It fell a full percentage point from 31.7 to 30.7.

The extreme example of the effect of the narrowing regular- premium spread is in California, where the gap was almost 10 RON in 1958. When regular rose 2 octane numbers in 1959, reducing the spread, the premium sales ratio dropped from 51.5% to 47.6%. The ratio has since fallen to 46 3%.

The oil industry is quick to point the finger at Detroit as the villian in the new octane race in regular gasoline. But marketers are also wondering about the effects of some of their own practices which may be hurting premium sales.

There is a trend among some companies toward pushing regular gasoline. The octane has been raised significantly and regular has been improved in other ways. Anti-stalling and anti - icing additives, which traditionally belong to premium, are being put into regular.

And regular is in some cases advertised aggressively.

The effect, according to one exasperated marketer, is to start a game of "musical pumps." His theory is that you don't win any customers from a competitor. You merely boost regular sales at the expense of your own premium.

This type of selling, he reasons, destroys much of the difference between the two grades. And so there is less reason for buying premium.

Rapid upgrading of antiknock and other regular qualities is a self-accelerating trend which one company believes could lead to eventual confiscation of the premium market.

Optimum regular octane? . . . There is a segment of the refining industry which believes there is an optimum level for regular-grade octane.

This number would permit U. S. consumers to achieve the least costly operation of their cars. And the industry appears already to have passed that level, which is estimated to be between 90 and 92 RON.

A continuation of the current rate of regular-octane increase could raise the level to 96 RON by 1966. If this comes to pass, one estimate places the extra and unnecessary cost at $450 million per year.

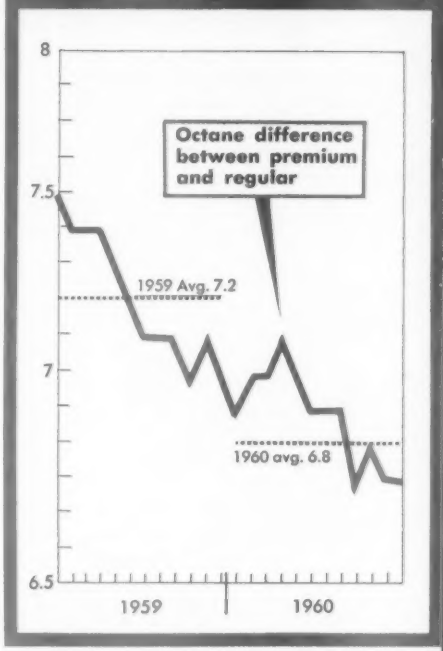
An optimum octane would provide the best balance of total cost of motor fuel for both premium and regular grades. The problem is to balance motor-fuel grades against the needs of cars.

At the beginning of this year, the 92.5 regular would satisfy at light knock 80% of all cars on the road; it would satisfy 63% of the cars at trace knock. A 90-RON gasoline would satisfy 65% of the cars at light knock and 45% at trace knock.

The closer regular approaches premium, the smaller the saving to the motorist using regular.

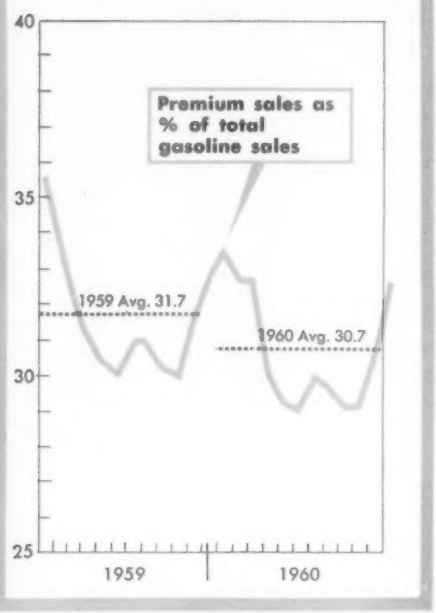
The figures suggest that the lowest over-all gasoline cost is reached

Octane Spread Narrows



Extra Millions

Premium Sales Ratio Drops



at about 92 RON for regular. This assumes a two-grade system with a premium of 99 selling at 35 cents a gallon retail.

As regular octane drops below 92, however, increasing numbers of motorists must use premium. Their added costs will outweigh the cost savings to other motorists if regular grade is below 92 RON.

In a three-grade system, with a 98-octane middle grade, a regular of about 90 appears to be the optimum, according to these calculations. This system would provide the public a bonus of 0.2 cents a gallon on all gasoline bought.

These figures indicate a further advantage in a multi-blend type of system if the middle-grade octane is 96.

The implications . . . Since premium octane requirements have leveled off, the continued rapid rise in regular octanes could result in large economic waste.

With this in mind, some companies have urged Detroit to take it easy on regular—or even to call a halt to designs which push regular to even higher levels than today's.

One of the companies says manufacturers should not design cars which require octanes above 90 RON—or 92 as a maximum—if they are intended to use regular.

"Car manufacturers have an important public responsibility in avoiding any push on regular octanes that could cost the public unnecessary motor-fuel charges that could range into hundreds of millions of dollars," this company declares.

BP Buys U. S. Production

BRITISH Petroleum Co., Ltd., will move into the U. S. production and exploration scene the middle of April through the purchase of two producing companies headquartering in Los Angeles.

BP is buying Kern Oil California, Ltd., and St. Helens Petroleum Corp.

The deal that netted BP the two U. S. firms also involves the purchase of Kern Trinidad Oilfields, Ltd., and a 25% interest in Devon-Palmer Oils, Ltd., a Canadian producing firm. The sale is scheduled to become effective the middle of this month.

The companies are all subsidiaries of Kern Oil Co., Ltd., which in turn is a subsidiary of Rio Tinto Co., Ltd., a mining firm operating out of London. The deal will take Rio Tinto out of the oil business for all practical purposes.

BP has offered 3 million shares of stock valued at around $25 million for the oil properties. The company will acquire 2,600 bbl. of daily production in California, about 100 bbl. in the Rockies, and 28,000 bbl. in Trinidad.

The deal will give BP its first U. S. production. The company holds an interest in Richfield Oil's wildcatting operations in southern Alaska, but has no other U. S. production.

If BP follows the pattern established in Canada, the purchase of the producing properties is a step toward an integrated operation in the U. S.

Gulf Wins Purchasing Case

THE Oklahoma Supreme Court has ruled that the state's Corporation Commission does not have power to require a crude-oil purchaser to take the full allowables from wells to which it is connected.

The ruling ended a 3-year legal bout between the commission and Gulf Oil Corp. The OCC had fined Gulf $305,000 for contempt because it instituted purchaser proration without first getting approval.

The proration took place in August and September 1957 when there was a surplus of crude following the Suez crisis. The commission ordered all purchasers to take full allowables unless given special exemptions.

Several purchasers applied for and received permission to prorate, but Gulf prorated to approximately 80% of allowables without asking permission.

The commission fined Gulf $5,000 a day for 61 days. Gulf sought relief in the federal courts and carried the case to the U. S. Supreme Court, but was told to exhaust its remedies in state courts first.

The Oklahoma Supreme Court said OCC has no authority to require a purchaser to buy a given volume of crude and therefore it cannot require a purchaser to obtain its consent to the amount it will buy.

Commission attorneys argued that OCC cannot enforce the ratable-take statutes unless it has some jurisdiction over the amount and method of purchaser proration. The court did not pass on this point directly, and apparently the decision has no effect on other methods used to enforce ratable take.

While the case was pending Gulf sold its Oklahoma gathering system to Kerr-McGee Oil Industries and is no longer a purchaser in the state.

Russian Gas Experts May Visit U. S.

A RUSSIAN delegation of natural-gas experts will visit U. S. gas industry installations next month if current negotiations are successful.

An American delegation then will pay a reciprocal visit to Russia in July. The exchange tours will be similar to those made by oil men of the two countries last year (OGJ, Nov. 21, 1960, p. 154).

The American Gas Association, which is assisting the State Department in planning the new exchange, said arrangements have not yet been approved by the two governments.

AGA is reportedly revising a proposed schedule which the Russians rejected.

Mecom Rig Headed for Yemen

- **First shipment of drilling equipment leaving Galveston for Houston independent's new concession.**

JOHN W. MECOM, Houston independent, will ship a drilling rig and other equipment from Galveston this week to his new concession in Yemen, where drilling will start about June 1.

The 10,000-sq.-mile concession is located in the northern part of the small country which lies at the bottom of the Arabian Peninsula.

Exploration equipment already has arrived via the Red Sea port of Salif, and three crews are core drilling and making gravitometer surveys. Chief structures being surveyed are salt domes.

Spudding date and location of the first well will depend on results of the exploration work.

A Mecom spokesman figures the first well will be started about 60 days after the drilling equipment leaves Galveston, April 5.

Since exploration is in the Salif area, drilling equipment can be transported from the port to the drilling site by road.

Mecom has negotiated a deal with Yemen which calls for an approximate 50-50 split. He has 5-year exploratory rights and 30 years for development. The concession is on the Yemen coastal plain and in offshore waters. First drilling will be onshore.

Yemen has never been drilled for oil.

In 1959 an American firm, Overseas Investment Corp., held a concession which is roughly the same as Mecom's, but no drilling occurred. W. Angie Smith III, who headed Overseas Investment, has joined Mecom's organization in Houston and is assisting in liaison on the Yemen project.

Operating headquarters will be in Rome and field headquarters at Salif. Foster J. Schempf, a key man in Houston for Mecom, will be in charge of the Rome office.

Independents vote to merge

THE MERGER of North Star Oil Co., Los Angeles, and Westwater Corp., Midland, has been approved by directors of the two independent firms.

North Star Oil Corp. would be the name of a merged firm, which would have reserves estimated at 2,500,000 bbl. The two companies have an interest in 50 wells in West Texas and New Mexico.

William Moss, president of North Star, is scheduled to become president of the merged firm. Charles C. Green, Jr., Westwater's president, is slated to direct exploration activities from Midland. Green is a former independent operator and at one-time was a geologist for Texas Gulf Producing Co. and later Shell Oil Co.

Moss and Green would be directors of the new company along with Jack C. Vaughn, Dallas; Christian R. Holmes, San Francisco and San Antonio; LeRoy Hines, San Francisco; and J. E. Brosseau, Santa Fe. Stockholders still must approve the proposed merger.

Market Fight

UNPRECEDENTED competition in the marketplace is causing hard reappraisals of selling methods used by major marketers.

And this soul-searching in turn has touched off the biggest rash of advertising-agency switches in the history of the oil industry.

Since December 1, Madison Avenue has been jolted by four agency changes by major companies:

... **Mobil Oil Co. dropped** Compton Advertising, Inc., its agency for 18 years, and picked up Ted Bates and Co., known for its hard-sell methods.

... **Shell Oil Co. quit** J. Walter Thompson Co., ending a 30-year relationship, in favor of Ogilvy, Benson and Mather, Inc., which sold Shell on "one deafening barrage" of newspaper ads.

... **Cities Service Co. left** Ellington and Co., its agency for 13 years, and retained Lennen and Newell.

... **Continental Oil Co. replaced** Benton and Bowles, Inc., its agency for 7 years, with Clinton E. Frank. Benton and Bowles resigned the Conoco account when it made a pitch for the more lucrative Shell business.

Because the oil industry is known

PROCESSING

Gas-processing plant of Home Oil Co. at Carstairs, Canada, will be expanded from a capacity of 70,000 M.c.f.d. to 200,000 M.c.f.d. at an estimated cost of $4.3 million. Fluor Corp. of Canada will be contractor on the job which is expected to be completed in November.

Gas-liquids-plant expansion has been completed by Continental Oil Co. at Lake Charles, La. Capacity was raised from 100,000 M.c.f.d. to 150,000 M.c.f.d. Hudson Engineering Co. was contractor for the $2-million project.

Polyethylene capacity will be expanded an undisclosed amount at W. R. Grace & Co.'s 50-million-pound plant in Baton Rouge. Fluor Corp. has received a contract to

Strategy Seen in Advertising-Agency Changes

for long and happy advertising agency-client relationships, the sudden severance of arrangements of many years' standing has caused more than a little eyebrow lifting.

Why the changes? . . . The switches appear to be more a result of the intensified market battle than any specific dissatisfaction with advertising programs.

Possible motives range from fears that previously effective campaigns have lost their punch to desire for a larger share of the market and hopes that a new agency can bring a fresh approach that might restore the punch.

Caught between a slackened rate of demand growth and a drive by many majors into new territory, marketers are under pressure to boost sales against odds which are greater than ever. And so more results are being demanded of advertising campaigns, spurring ad managers to try something new.

In the case of Mobil and Cities Service: They have just undergone extensive corporate reorganizations and approaches to every company activity — including advertising — have undergone sharp scrutiny.

"We've had different approaches in the past," a Mobil spokesman explains. "From here on, we will be more research-oriented.

"What we say on the air and in print we know will be something that will persuade people to buy. We believe advertising can make a bigger contribution to sales than it has in the past."

Commenting on the Bates agency's aggressive selling reputation, the spokesman says, "This will be neither the hard sell nor the soft sell, but the smart sell."

Cities Service expressed complete satisfaction with its previous agency, and said the switch was made with the greatest reluctance.

"In the end, it was dictated by the fact that at this important time in our corporate life, when four affiliates have been merged into one, a whole new approach to marketing is planned.

"It was felt that new thinking was needed in advertising. It is hoped that a new agency with new creative people will provide a fresh approach that will put a new spark in our advertising."

Mobil and Shell agencies . . . Mobil's hiring of Bates has intrigued Madison Avenue because of the unusual way in which Bates landed the $6-to-$7-million account.

J. D. Elgin, Mobil Oil advertising manager, read an advance copy of a book "Reality in Advertising," by Rosser Reeves, chairman of the Bates agency. Elgin was so impressed that he went to the agency and swung the account over.

The Shell switch to Ogilvy has caused an immediate and spectacular turn in strategy that is apparent to anyone who reads a newspaper.

Ogilvy sold the company on the idea that the way to make its voice heard above the crowd was a saturation newspaper campaign that told "the real facts about gasoline and oil."

The result has been full-page "bulletins" with large blocks of copy detailing the nine ingredients in Super Shell to readers of 325 newspapers across the country.

Ogilvy has convinced Shell it should pour almost all of its $13 million in advertising into newspapers, rather than scatter its shots.

Next year, concentration could be in television — the important point being to concentrate the firepower.

BRIEFS . . .

design the expansion. Completion is expected in August.

A concentrated benzene fraction will be produced by Texas Gas Corp. at its Winnie, Tex., plant. Modifications under way will provide a capacity of 9.9 million gal. annually of a product that will contain 60% benzene plus C_7 and heavier.

An ammonia plant will be built by Shamrock Oil & Gas Corp. at its Sunray, Tex., refinery. Capacity will be 150 tons per day. Completion is expected in early 1962.

Major chemical complex will be built at Geismar, La., by a new company, Monochem, Inc., jointly owned by Borden Co. and U. S. Rubber Co. Contracts have been awarded to build an acetylene and vinyl chloride monomer plant at the 850-acre site. The $20 million plant is expected to be on stream by late 1962. Contractors are: Chemical Construction Corp. and United Engineers & Constructors, Inc.

A gas-processing plant with 15,000 M.c.f.d. capacity will be built by Shell Oil Co. at Sealy field, Austin County, Texas. Delta Engineering Co. has the contract to construct the refrigerated-oil absorption plant which will be designed for 75% propane recovery. Completion is scheduled for September 1.

A vacuum flasher for asphalt production will be built at Shell's Martinez refinery near San Francisco. Bechtel Corp. has the contract for the job. The unit is slated to go on stream in October.

Also for Refiners . . .

IN THE NEWS: Refining capacity is still growing and the burdensome over-capacity will exist in the U. S. for some years, Journal survey shows (p. 93) . . . Refiners show growing concern over narrowing octane spread between regular and premium and the decline in sales of premium (p. 106) . . . Southwestern refinery runs top 90% capacity in February (p. 110).

PLUS THE ANNUAL REFINING ISSUE: Selected processes (p. 115) . . . Survey of capacities of U. S. refineries (p. 164) . . . Survey of Canadian refineries (p. 185) . . . Refinery construction projects (p. 189).

Southwestern Runs Go Over 90% of Capacity

• February runs in five southwest states increased 1.9%. The national average was 1.1% over January for a total of 8,413,000 bbl. daily.

REFINERS in Arkansas, Louisiana, Mississippi, Oklahoma, and Texas accounted for about 41.8% of U. S. crude runs during February.

The region followed roughly the national trend, increasing crude runs by 1.9% over January. Nationally, throughput was at a record high, as daily average runs topped 8,413,000 bbl., for an increase of 1.1% over January.

Southwestern refiners operated at 91% of calendar-day capacity, contrasted to 84.7% for the nation as a whole. Area throughput was 3,520,000 bbl. per day, up 65,000 bbl. daily over January and 184,000 bbl. daily over February a year ago.

The 91% level corresponded to that of refiners in the Mid-Continent area, although it was considerably higher than the 78% average maintained on the East Coast and West Coast. It fell short, however, of the 99% level maintained by refineries in the Dakotas, Minnesota, and Wisconsin.

ARKANSAS

(Refinery Runs in Barrels Daily)

Company and location—	February	January	February 1960
American, El Dorado	40,619	36,937	34,344
Lion, El Dorado	35,336	32,817	34,412
MacMillan, Norphlet	3,607	3,128	2,694
Other	6,335	4,764	6,155
Total Arkansas	85,897	77,646	77,605

LOUISIANA

(Refinery Runs in Barrels Daily)

Company and location—	February	January	February 1960
Cities Service, Lake Charles	175,068	175,004	175,097
Continental, Lake Charles	59,505	46,348	56,617
Humble, Baton Rouge	342,702	324,729	283,327
Ingram, Meraux	20,316	20,040	19,406
Shell, Norco	98,333	97,754	102,349
Tenneco, Chalmette	45,156	44,054	21,032
Other	8,836	6,700	7,942
Total Louisiana	749,916	714,629	665,770

MISSISSIPPI

(Refinery Runs in Barrels Daily)

Company and location—	February	January	February 1960
Paluxy, Yazoo City	1,192	1,249	1,150
Pontiac, Hattiesburg	16,415	16,390	13,764
Southland, Sandersville	4,366	4,167	3,758
Total Mississippi	21,973	21,806	18,672

OKLAHOMA

(Refinery Runs in Barrels Daily)

Company and location—	February	January	February 1960
Allied, Stroud	2,877	1,570	2,782
Anderson-Prich., Cyril	9,441	10,144	10,379
Bell, Grandfield	6,571	6,341	6,813
Ben Franklin, Ardmore	8,304	11,435	11,783
Champlin, Enid	26,553	26,566	25,554
Cities Service, Ponca City	32,233	30,223	28,255
Continental, Ponca City	64,810	70,372	70,721
DX Sunray:			
Duncan	40,220	41,042	35,973
Tulsa	70,469	70,859	67,471
Kerr-McGee:			
Cushing	18,287	18,125	23,057
Wynnewood	17,983	17,848	15,748
Midland Co-op., Cushing	13,243	13,370	12,808
Phillips, Okmulgee	13,061	14,376	16,903
Texaco, Tulsa	*	*	41,795
Total Oklahoma	324,052	332,271	370,042

*Not reported to Oklahoma Corporation Commission.

TEXAS

(Refinery Runs in Barrels Daily)

Company and location—	February	January	February 1960
American, Texas City	142,604	127,091	100,249
Am. Petrofina:			
Mount Pleasant	15,159	16,342	14,275
Wichita Falls	6,633	6,598	4,679
Atlantic, Port Arthur	64,453	65,650	67,376
Col-Tex, Colorado City	7,681	7,680	7,113
Continental, Wichita Falls	9,459	11,266	11,495
Cosden, Big Spring	28,805	28,984	28,819
Crown Cent., Houston	34,990	34,155	31,533
Delhi-Taylor:			
Corpus Christi	43,066	44,233	36,210
Port Isabel	5,266	5,152	5,172
Eddy, Houston	2,015	2,031	2,068
El Paso, Odessa	11,158	11,441	0
Gulf, Port Arthur	278,741	282,072	278,942
Howell, San Antonio	2,208	2,324	2,627
Humble, Baytown	292,306	310,218	295,579
La Gloria, Tyler	16,896	16,799	15,646
Mobil, Beaumont	208,352	217,105	199,482
Phillips:			
Phillips	57,496	53,159	60,688
Sweeny	74,037	69,615	74,161
Plymouth, Texas City	35,069	29,979	25,689
Pontiac, Corpus Christi	48,213	50,394	47,881
Premier:			
Fort Worth	7,787	7,741	7,790
Longview	3,237	2,065	826
Pure, Nederland	84,070	79,475	76,960
Shamrock, Sunray	19,338	23,384	23,251
Shell, Houston	127,798	115,537	85,833
Signal, Houston	48,182	47,052	47,482
Sinclair:			
Corpus Christi	19,900	16,070	28,520
Houston	127,821	128,430	126,445
Skelly, Longview	3,039	3,077	3,036
Southwestern, Corpus Christi	31,145	31,837	29,491
Stand. Tex., El Paso	51,353	50,532	48,738
Suntide, Corpus Christi	43,487	43,793	38,722
Texaco:			
Amarillo	16,653	16,920	16,828
El Paso	7,406	12,118	13,733
Port Arthur	267,871	234,679	257,404
Port Neches	37,201	40,398	39,716
Texas City, Texas City	34,514	38,121	27,402
Other	22,670	25,047	22,546
Total Texas	2,338,079	2,308,564	2,204,007

Sahara Oil: Major Issue in Peace Talks

• Four years ago neither the French nor Algerians would have cared much about controlling the Sahara. Now new oil in the area makes this one of the knottiest problems in negotiations to end the guerrilla war.

Paul Swain
International Editor

WHEN THE FRENCH and Algerians sit down this week on neutral ground at Lake Geneva to talk about ending a bloody 6½-year-old guerrilla war, one of the knottiest problems they'll have to solve is the future of the Sahara's oil.

First they'll have to talk about the political problems that spawned the war. They'll have to decide whether a cease-fire comes before or after the real peace talks. The future French position in Algeria will have to be settled.

Biggest problem of all will be a definitation of territory when they talk about the "self-determination" that has become a political byword.

Are the Algerians going to determine the political future of the Algeria "north of the Atlas Mountains" — or Algeria including the vast Sahara Desert?

At one time this wouldn't have been too much of a stumbling block from a political standpoint. About all the Sahara meant was 900,000 sq. miles of sand and 580,000 nomadic people. The forbidding and inhospitable region would hardly have been worth an argument.

Vast mineral wealth in that great "sand sea" is now a major issue. The questions of who'll control it and who'll benefit from it are rapidly becoming the keys to any peaceful settlement of the Algerian problem.

Oil is a lately arrived complicating factor. Saharan oil on the surface is only half as old as the war itself.

This oil is important to both France and Algeria. The French have had it just long enough to whet an appetite for more. Algerians, trying to shake off colonial bonds, regard it as the biggest single asset for a healthy and independent economic future.

There are extremists on both sides.

Some Algerians vow that the French must surrender any and all claims to both Algeria and the Sahara.

Highly placed French spokesmen, including Premier Michel Debre, have said publicly that France will never give up the Sahara. They contend the Sahara is not a part of Algeria or the Algerian political problem. They would deal separately with the two areas.

Somewhere between these extremes lies a solution to the war that has cost the French huge amounts of money and thousands of lives.

The situation now . . . As recently as 4 years ago, the Sahara had no visible oil. Then the concentrated exploration effort of French companies began to pay off. Today there are 14 known oil fields in the Sahara, at least a dozen of them major fields.

Last year the French pumped a daily average of 182,520 bbl. of very high quality oil out of the Sahara through two 24-in. pipelines to the Mediterranean coast.

This year the pipeline throughput could easily reach 350,000 bbl. daily.

By 1965, the French expect to be moving from 500,000 to 600,000 bbl. daily into European markets—primarily French ones.

All this is linked to oil reserves estimated conservatively at more than 5 billion barrels.

The gas fields discovered so far in the vast desert probably equal the oil strikes in number. Eventually they may be just as valuable.

At present there are more than 20 French companies prospecting in the Sahara. Added to these are 6 American oil companies, 2 German, and one Italian firm, all as minor partners with the French companies.

The French have insisted from the beginning that they have control of any oil operation in the region.

Royalties on Saharan production, based on 50% of operating-company profits, are now divided between Algeria and the French governmental organization administering the Sahara and the neighboring states of Niger and Chad.

This department is using the 25% income it gets from Saharan oil to build roads, airports and additional water supplies in the remote desert areas.

It is estimated that the total Sa-

Cities Service Hits in Sahara

CITIES SERVICE has found a substantial show of oil in a deep wildcat test in the northern French Sahara.

A test recovered 40°-gravity crude from a 17-ft. section between 12,608 and 12,625 ft. in Oulouga 1.

The well, 80 miles northwest of Hassi Messaoud oil field, is on an 888-sq.-mile concession in which Cities Service holds 49% interest. Two French partners hold the remaining interests.

haran oil royalties this year will amount to a tidy $29 million and by 1965 will reach at least $60 million.

So the chips in the game to be played this week at the little French resort town on Lake Geneva, Evian-les-Baines, are nearly all blue.

The French position . . . Except for generalities, little is actually known of the official French position in the approaching negotiations. The preliminary talks have been held in secret.

Few people now believe that the French can successfully partition the problem and deal with an Algeria that excludes the Sahara.

Efforts in this direction were started several years ago when an administrative change divided the two regions.

The French began to talk officially of the Sahara as a separate entity shortly after this. French maps today divide the two as separate areas, but this is largely wishful thinking. The Algerians certainly will resist it in any negotiations.

President Charles de Gaulle, working in opposition to many Frenchmen at home and nearly all the French in Algeria, has been able to bring things to a talking stage by actively backing a "Maghreb Federation," — the old North African Arab dream—linking Morocco, Algeria and Tunisia.

This has brought him the active help of both President Bourguiba of Tunisia and the new King Hassan II of Morocco.

The aloof De Gaulle remains silent on his basis for dealing with the Algerians. But there is widespread speculation in Europe that he may propose some sort of consortium of governments and oil companies to run the Saharan oil industry, possibly under Algerian political control if there is some ironclad guarantee the oil companies would be allowed to continue operations.

Such a plan would mean that oil royalties would go not only to Algeria and the Sahara, but also to Tunisia, Morocco, and the other former French colonies which border the Sahara on the south.

The Algerian position . . . More is known, at least from a negative standpoint, about the viewpoints of the Algerian nationalists. These attitudes are widely publicized by nearly every member of the Algerian Provisional Government.

Less than a month ago, Dahlab Said, secretary general of this Algerian Government - in - exile, said flatly that the Algerians wouldn't even discuss peace terms or settlement with the French if any question arose on Algerian sovereignty over the Sahara.

He added that this did not mean there is no possibility of agreements with France and with the Sahara's neighboring countries in regard to oil development and production.

As things now stand, the best European observers can only guess at the outcome of the talks on the Swiss-French border.

They are guessing that one of six possible solutions in regard to the Sahara may be reached. These are:

. . . **The status quo,** with France keeping her control of the Departments of "Oasis," as the French now call Algeria proper, and the Sahara. This, of course, would not be acceptable at all to the Algerian nationalists.

. . . **The Sahara as a part** of Algeria. This is the position most often demanded by the FLN, the nationalist group headed by Ferhat Abbas.

. . . **Joining southern Sahara** to the northern Saharan region just south of the Atlas Mountains. The northern Sahara is more developed and more "Algerian" than the southern region where oil production has been established.

. . . **An independent** Saharan state. This would not be acceptable to the nationalists.

. . . **A French Sahara** with the neighboring states of Tunisia, Algeria, Morocco, Spanish Morocco, Mauretania, Mali, Niger, Chad, and Libya all getting a cut of the oil income. The political problems involved in this solution would be tremendous.

. . . **A consortium** of border states with direct management and administration of the Sahara, including its oil.

Whatever the political solution arrived at by the negotiators, oil is a primary factor. The talks at Lake Geneva are expected to take weeks and a final solution will not come easily.

How Colombia's

COLOMBIAN OPERATORS are weighing a new oil law that will sharply increase the cost of doing business in the country in the future.

Among other things, the law ends the 50-50 profit split which has limited income tax and royalty payments to a maximum of 50% of the net.

Colombia continues to recognize rights acquired under existing contracts, and the new law does not affect existing exploration and producing operations.

The measure increases surface rentals and royalties on government lands. And it raises the exploitation tax on private-land production.

Preliminary industry reaction is that it is untimely to increase exploration costs in a period of worldwide crude surplus.

Colombia's exploration record is far from spectacular. Output is still in the 150,000-bbl.-daily class after decades of search.

Only a handful of important fields have been found since the old law was passed in 1931.

These include Texaco's Velazquez and Palagua fields, averaging 27,000 and 10,000 bbl. daily; Colombian Petroleum's 25,000-bbl. Cicuco field and its Barco complex; and Shell's 19,000-bbl. Casabe

FOREIGN

A voice in Khafji field operations has been given to Saudi Arabia and Kuwait by Arabian Oil Co., the Japanese-based firm which will soon start moving crude from the Persian Gulf discovery off the Neutral Zone. The company will issue 5 million shares each to the Saudi Arabian and Kuwait governments, and also has agreed to name three nationals of each country to executive posts in Arabian Oil.

A new refinery in Southern Rhodesia is slated by American Independent Oil Co. as soon as a contract is signed with the government. Officials say the refinery will be operating by the end of 1963 and

New Oil Law Will Drive Up Operational Costs

BP Plans Colombian Venture Under Law

BRITISH PETROLEUM expects to apply for exploration rights in Colombia under a special provision of the country's new oil law.

The law permits firms in which foreign governments have an interest—as in the case of BP—to take up concessions if the firm contractually renounces any right to call for diplomatic intervention by the interested government.

This provision, in practice, has been required in concession contracts signed by private companies.

BP, in the past, has been prevented from operating in Colombia and some other countries—notably Venezuela—because controlling interest in the company is held by the British Government.

field and Cantagallo, Yariqui, and San Pablo producing complex.

Actual operation of the law will be carried out under regulations to be issued by the executive branch of government.

The increases . . . The new law expresses rental fees on a concession acreage in terms of U. S. dollars per hectare, rather than in Colombian pesos.

In western Colombia the sliding scale of rentals will rise to $3.00 per hectare over a 6-year period, after which payments will level off. Under the old law, rentals ranged from the equivalent of about 3.5 cents to 45 cents (U. S.) per hectare.

In eastern Colombia's Llanos area, where commercial production is yet to be established, rentals will rise from 10 cents to $1 per hectare, compared with 1.5 to 7.5 cents previously.

Royalty payments on future production from government lands will be 11.5% in the Llanos, and 14.5% elsewhere.

The old law provided for a royalty varying from 3% in the Llanos to 13% in the coastal area, depending on the distance from Tidewater.

Royalties will be payable in cash or kind at the option of the government, which can request payment in either U. S. or local currency. Royalty on gas production will be the same as for oil.

Exploitation taxes on lands where private owners hold subsurface rights will be 6.5% in the Llanos and 8.5% elsewhere, also payable in either cash or kind.

This tax formerly varied from 0.5% on areas more than 560 miles from tidewater to 7% in regions closer to the coast.

Concession reductions . . . The new law cuts in half the acreage maximum for each concession. In the west the limit is now 25,000 hectares, and in the Llanos 100,000 hectares.

The original area must be reduced by 50% in the first year of exploitation. The relinquished areas may again be put up for bidding on terms more favorable to the government.

Exploration periods will now be 8 years in the Llanos and 6 years elsewhere, reduced from 13 and 11 years.

The drilling obligation is similar to the provision in the old law, except that minimum footage figures are now specified.

Exploitation periods will be granted for 30 years in the west with provision for longer periods if a commercial discovery is made in the Llanos.

Depletion allowance . . . A normal depletion allowance of 10% of the gross value of oil and gas produced and saved, less royalties, will be granted. This will be limited to 35% of total net income before depletion.

Operators will get this allowance until capital investment, other than investment in depreciable land or property, is amortized. When the investment is amortized, an income-tax exemption of 10% of the gross will be made.

As to exploitation started after January 1, 1955, another 15% special allowance—18% in the Llanos—will be permitted after the initial investment is amortized, if the allowance is invested in exploration, refining, pipelines, or power plants in the country within 3 years.

The totals of both normal and special depletion are not to exceed 45% of net income.

Under the old law, an allowance of 25% of the gross—28% in the Llanos—was made if an operator spent $800,000 a year outside his producing concession.

BRIEFS . . .

will form the nucleus of a $50-million petrochemical complex. Announcement of the plant marks the latest development in a struggle between established marketers and newcomers fighting to expand.

Iran has begun exporting products to Afghanistan under a new trade agreement which calls for shipments of 350 bbl. daily.

A top Russian trader is in Tokyo to negotiate a barter exchange of 10 million tons of crude, or about 70 million barrels, in return for Japanese steel pipe and two 35,000-ton tankers. E. P. Gurov, chairman of the Soviet Petroleum Corp., is reportedly seeking the pipe to help extend the Trans-Siberian pipeline to the Pacific coast.

Bigger tankers are being handled by the Suez Canal in a deepening program. Tankers drawing 36 ft., 6 in. of water now can pass through. This is an increase of 6 in., and will allow a 42,000-ton tanker to carry an additional 6,000 bbl. of oil. Eventually tankers with 37-ft. draft will be handled.

A light petroleum fraction is replacing coke as a hydrogen source at Imperial Chemical Industries, Ltd.'s chemical-production complex in Billingham, England. Formerly, ICI produced 600,000 tons of coke a year.

World Flow Up Again

- **January's record showing in free-world fields, plus U. S. gains, lifted crude output to all-time high.**

FOREIGN oil fields started the new year by breaking all previous production records in January.

Free-world fields outside the U. S. averaged better than 11.4 million barrels daily for the first time.

A relatively high U. S. output, combined with the record foreign production, sent total world output to a higher level than ever before.

A gain of 199,800 bbl. daily in Venezuelan production was one of the key factors in the over-all rise. It was the second month in history in which the country's operators produced more than 3 million barrels daily.

Saudi Arabian production rose to an all-time high of 1,436,700 bbl. daily, pacing record production in the Middle East.

TREND OVER THE LAST YEAR

(Thousands of barrels)

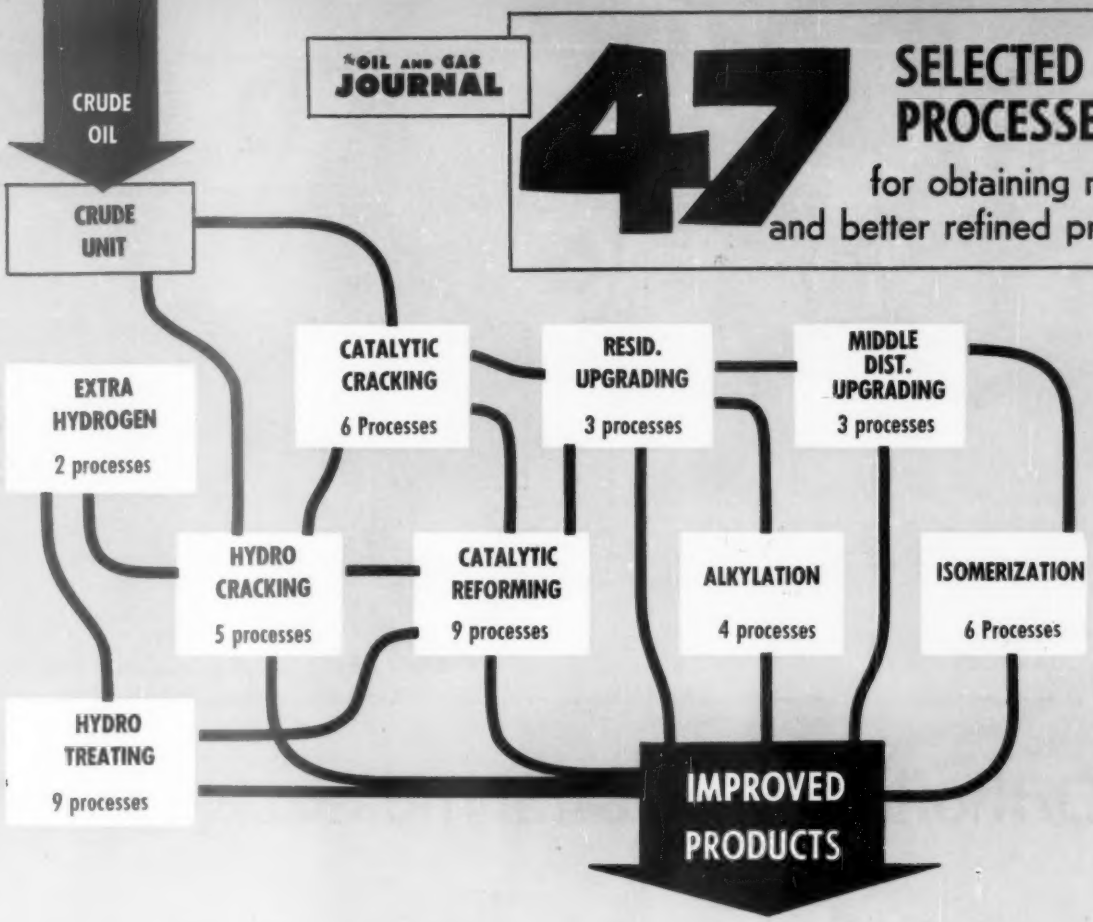
	Western Hemisphere less U. S.	Middle East	Total free world outside U. S.
1960			
January	4,304.0	5,069.2	10,377.1
February	4,389.5	4,986.5	10,313.2
March	4,156.4	5,146.3	10,346.8
April	4,069.5	4,925.5	10,055.1
May	4,317.4	5,286.2	10,680.2
June	4,285.4	5,164.5	10,568.2
July	4,214.2	5,103.5	10,448.2
August	4,320.1	5,146.8	10,602.5
September	4,311.3	5,500.2	10,941.3
October	4,243.9	5,630.6	11,104.5
November	4,206.8	5,482.2	10,964.2
December	4,341.2	5,550.1	11,152.2
1961			
January	4,594.1	5,568.1	11,418.8

World-Wide Crude Production: Daily average in thousands of barrels

Country—	Jan. 1961	Dec. 1960	Jan.1960
Western Hemisphere			
Argentina	239.1	231.9	137.1
Bolivia	7.8	7.8	8.7
Brazil	92.0	92.0	75.6
Canada	591.0	540.9	490.9
Chile	22.0	22.0	18.8
Colombia	152.7	156.9	158.0
Cuba	0.2	0.2	0.5
Ecuador	7.7	7.7	7.4
Mexico	271.0	271.0	262.0
Peru	52.5	52.5	51.5
Trinidad	125.3	125.3	114.8
Venezuela	3,032.8	2,833.0	2,878.7
Total	4,594.1	4,341.2	4,304.0
Europe			
Austria	46.0	46.0	46.0
France	38.1	40.5	35.9
West Germany	112.9	110.3	102.2
Italy	33.2	40.4	30.1
Netherlands	38.9	38.9	33.0
United Kingdom	1.7	1.7	1.5
Yugoslavia	21.2	23.5	12.1
Total	292.0	301.3	260.8
Middle East			
Bahrain	45.1	45.1	45.1
Iran*	1,121.0	1,158.0	999.0
Iraq†	1,034.2	975.3	903.2
Israel	2.3	2.3	2.4
Kuwait	1,596.3	1,647.0	1,583.4
Neutral Zone	145.3	154.4	126.4
Qatar	180.8	169.6	181.3
Saudi Arabia	1,436.7	1,392.0	1,221.2
Turkey	6.4	6.4	7.2
Total	5,568.1	5,550.1	5,069.2

Country—	Jan. 1961	Dec. 1960	Jan.1960
Other Asia			
British Borneo	93.1	93.1	102.7
Burma	10.5	10.5	10.7
India	8.5	8.5	8.5
Indonesia	407.7	398.7	391.2
Japan	10.3	12.7	9.0
New Guinea	3.4	3.8	4.2
Pakistan	5.9	5.9	5.9
Total	539.4	533.2	532.2
Africa			
Algeria	315.0	316.0	111.1
Angola	1.2	1.2	1.0
Egypt	70.2	70.2	59.5
Middle Congo	2.0	2.0	.....
Gabon	15.1	15.3	15.3
Morocco	1.8	1.8	2.0
Nigeria	19.9	19.9	22.0
Total	425.2	426.4	210.9
Free World			
Foreign	11,418.8	11,152.2	10,377.1
United States	7,170.0	7,150.0	7,230.0
Total	18,588.8	18,302.2	17,607.1
Communist Countries in Soviet Orbit			
Romania	231.0	231.0	235.0
Russia	3,190.0	3,120.0	2,843.0
Other Communist	100.0	100.0	100.0
Total	3,521.0	3,451.0	3,178.0
WORLD TOTAL	**22,109.8**	**21,753.2**	**20,785.1**

Figures are from reliable industry reports or government sources. Estimates are made where complete reports are lacking. *Includes estimated 6,000 bbl. daily from Naft-i-Shah field not operated by Consortium companies. †Includes estimated 3,500 bbl. daily from Naft Khaneh field, operated by Iraq Government.



The 47 processes described in this section have one common characteristic: in one way or another they all deal with product improvement.

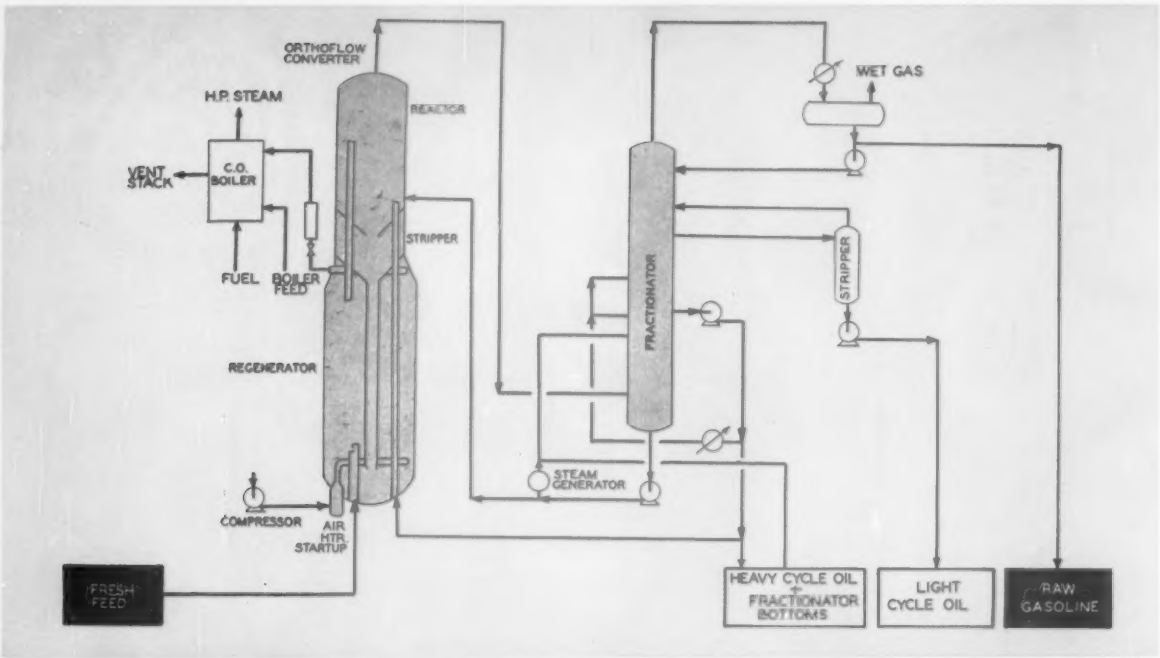
Most deal with gasoline fractions, some with middle-barrel distillates, and others with residual stocks. But whatever their purpose, they all are designed to help the refiner get more and better products from a barrel of crude oil.

As a group they will account for a large portion of the $468,000,000 U. S. refiners expect to spend this year for new facilities. Overblessed with crude capacity, and with the octane race at a standstill, much of this expenditure will be for replacing older units with larger units of improved design.

Many of the processes described in the following 47 pages will be employed because of the flexibility they offer in dealing with middle distillates and residuals.

Most of the new processes included here involve the use of hydrogen. With the commercialization of hydrocracking, and the much greater use of hydrogen for removing sulfur and other contaminants from distillate streams, the 14 processes covered in these two groups will find wide application.

And because of these greater demands on reformer hydrogen, some refiners are turning to hydrogen manufacturing. Two such processes are included.



Orthoflow fluid catalytic cracking

THE THREE Orthoflow designs provide straight-line flow of catalyst between vessels, virtually eliminating erosion normally encountered in pipe bends.

Two designs have been developed and proved commercially. In Model A the regenerator is located beneath the reactor and in Model B it is above the reactor. Both systems have economic applications; the choice depends on local costs.

The Model C design is a new modification of the Orthoflow principle. It selectively cracks the feed, resulting in lower yields of gas and coke and higher yields of liquid products. A simplified flow diagram of one version of the Orthoflow C process is shown above. Operating conditions are given in the table.

Description. Fresh gas-oil feed and recycle from the fractionator are admitted separately through the hollow stems of regenerated catalyst plug valves, sending hot regenerated catalyst upward to the reactor section. Riser cracking zones may extend to different levels in the reactor section. The regenerated catalyst plug valves also control the relative amount of catalyst fed to the individual riser pipes.

Segregation of the virgin-oil and recycle streams, and the control of catalyst feed to these streams, allow greater flexibility in the extent and temperature of cracking of the individual oil streams. Catalyst-bed level is maintained as an added control to over-all conversion of the feed.

The spent catalyst stripping zone is positioned centrally below the reactor section. Stripped catalyst flows downward through standpipes to the regenerator where it is contacted with air to reduce carbon content to the desired level.

The regenerator pressure permits optional recovery of power from the flue gas by an expander turbine. A CO boiler with supplementary firing may be used to generate steam, using CO in the regenerator flue gas as the primary fuel.

In the fractionator, reactor effluent is separated into gasoline, light gas oil, a recycle stream, and a slurry stream. Recovery consists of absorption and distillation towers to produce gasoline fractions as required and olefinic feed stock for catalytic polymerization or alkylation.

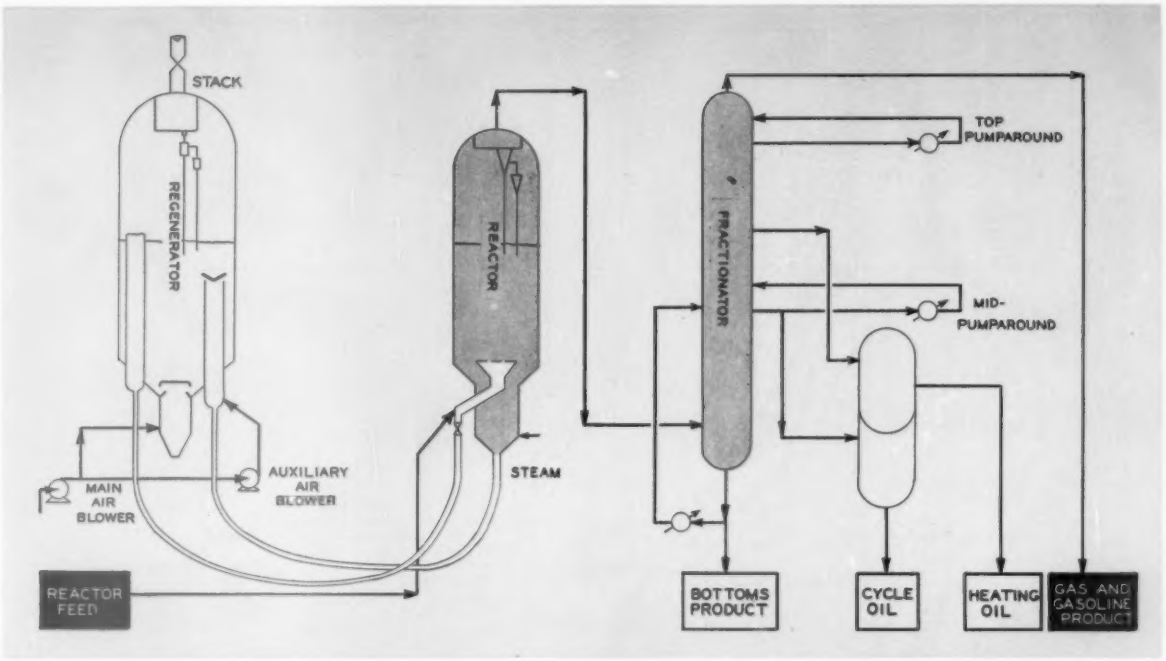
Other features. One of the major design achievements was the development of plug valves which regulate internal catalyst flow. These valves eliminate the need for expansion joints in many instances and are more easily maintained than conventional slide valves. Since no supporting steel is required other than the vessel skirt, appreciable savings in installation result.

Operating history shows that Orthoflow units have been remarkably free of erosion. The rate of erosion with plugs is considerably less than with slide valves and, unlike slide valves, the plugs inherently compensate for wear without loss of control.

OPERATING CONDITIONS FOR ORTHOFLOW C:

Reactor temperature	885°-950° F.
Reactor pressure	8-20 psig.
Regenator temperature	1,050°-1,200° F.
Regenator pressure	15-30 psig.
Catalyst-to-oil ratio	7-20 C/O
Space velocity, Wt./Hour/Wt.	1.0-16.0

Commercial data. Developed and licensed by M. W. Kellogg Co., 23 units of various Orthoflow designs are operating or in various stages of completion.



Model IV catalytic cracking

THE MODEL IV fluid catalytic cracking process converts gas oils and deasphalted stocks into excellent yields of high-octane gasoline. It also yields such important by-products as isobutane and light olefins for alkylation and polymerization, as well as for use in synthetic rubber and petrochemical manufacture.

Acceptable feed stocks range from light distillates to vacuum-distilled gas oils and deasphalted oils. By adjusting feed stocks to meet market conditions refiners can use their available crudes economically.

Process features. In Model IV units, the side-by-side location of the reactor and regenerator results in minimum over-all height. This alignment eliminates expansion and rotation joints. Substantially lower investment and operating costs in general result from the compactness of the unit and from improved mechanical and plant-layout features.

Absence of moving parts in inaccessible areas of critical wear locations contributes to low maintenance costs and short turnaround time. Except for the air blower, feed pumps, and the pumps and gas compressor in the products recovery section, there are no moving parts.

Catalyst flow. As shown in the flow diagram, the catalyst is transferred between vessels by means of U-bends, and at moderate velocities. In place of conventional slide-valve control, catalyst flow rate is varied by changing the amount of air injected into the spent-catalyst U-bend. Elimination of slide valves, by removing a principal point of erosion, contributes to longer runs.

Changes in air rates (using a portion of the regeneration air) vary the density in the riser, and thus change flow rate between vessels. Catalyst circulating rates as high as 70 tons per minute have been obtained.

U-bend transfer has proved to be very stable during upset periods. The catalyst in the bend not only acts as a seal between vessels during normal periods, but also impedes reverse flow through lines in the event of pressure surges. Model IV units return to stable operation as soon as pressures have been restored to normal levels.

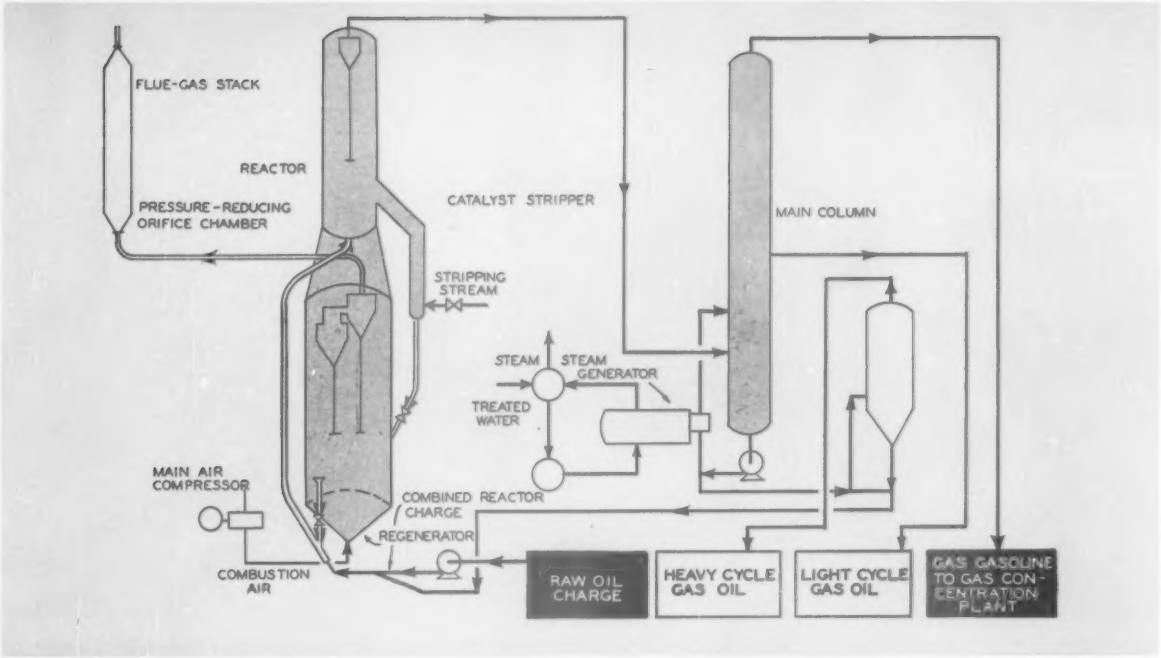
To permit positive shutoff during emergencies or serious upsets, a slide valve is provided in each U-bend. As these valves are normally out of the path of flowing catalyst, they suffer no erosion.

Spent catalyst, along with air used to control circulation, enters the regenerator through the spent-catalyst riser. Remainder of the air necessary for combustion enters the regenerator through a grid. Because only cool air—and no catalyst—flows through the grid, a carbon-steel grid can be used without concern for erosion or warpage.

Commercial data. At present, 37 Model IV units are in operation or being built. Their combined capacity is almost 750,000 bbl. daily. They range in capacity from 5,000 bbl. to 61,000 bbl. per day total feed. Seventeen of the units have been licensed to refiners outside the Jersey Standard circle. The process is licensed by Esso Research & Engineering Co., New York.

Typical of the flexibility of the Model IV process are these examples of product distribution:

Type operation—	Once through	Recycle— Moderate	Recycle— High
Product distribution:			
Dry gas, wt. %	8.5	8.6	8.5
Total C_4, vol. %	17.1	16.5	15.6
C_5-430° F., vol. %	43.8	51.8	57.0
Heating oil, vol. %	17.3	20.1	24.1
Heavy gas oil, vol. %	18.9	8.8	2.0
Carbon, wt. %	7.0	7.0	7.0



Fluid catalytic cracking (UOP)

THE UOP fluid catalytic cracking process is a modern, highly developed method of producing high-octane gasolines from a large variety of gas oils.

The fluid principle gives intimate contact between charge and catalyst in the reactor, and optimum regeneration conditions in the regenerator. Energy required for catalyst circulation is furnished by vaporizing the charge through direct contact with the hot, regenerated catalyst and by maintaining a reactor pressure lower than in the regenerator.

Charge stocks. A large variety of charge stocks from all types of crude oils may be cracked. Typical charge stocks include naphtha, kerosine, light gas oil, distillate, heavy atmospheric and vacuum gas oils, distillates from viscosity breaking or coking, and certain desalted crude oils.

High-sulfur feeds containing large amounts of nitrogen may be successfully processed without operating penalties. Because the charge is heated by direct contact with regenerated catalyst, a heavy charge which would rapidly coke up a feed preheater may be handled without difficulty.

Heat-balance unit. The flow diagram shown is typical for a 5,000-bbl. per stream day unit of the heat-balance type. This design eliminates feed preheaters and catalyst coolers. It also permits generating much of the steam required in process and as power for prime movers.

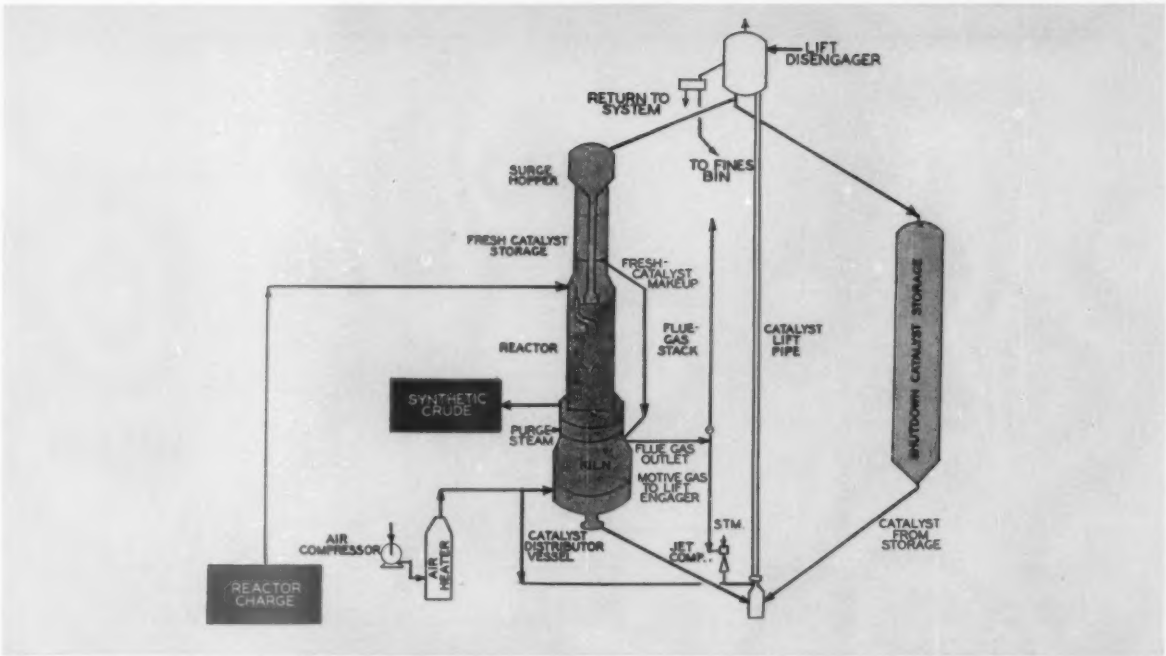
... Typical yields from a UOP fluid catalytic cracking unit, charging a 31° API Mid-Continent gas oil over a silica-alumina catalyst, are shown in Table 1 for once-through and recycle operation. Yields when charging a 27° API Oklahoma gas oil are shown in Table 2. UOP catalytic cracking units in operation or under construction range in size from 1,200 to approximately 35,000 bbl. per stream day of fresh feed. The process is licensed by Universial Oil Products Co.

TABLE 1—TYPICAL YIELDS

Operation—	Once-through	Recycle
Conversion, vol. % gas oil disappearance	60	75
Yields (vol. %):		
Debutanized gasoline	45.0	53.0
Cycle stocks	40.0	25.0
Butylenes	5.8	7.1
Butanes	8.7	9.4
Propylene	5.2	6.4
Propane	2.4	3.3
C_2 and lighter, wt. %	2.5	3.1
Octanes, 10-lb. R.v.p. gasoline:		
Motor method, clear	81.8	81.8
With 3 ml. TEL	86.8	87.4
Research method, clear	93.7	94.2
With 3 ml. TEL	98.7	99.1
Yields with polymerization, vol. %:		
10-lb. R.v.p. polymer gasoline	8.0	9.9
10-lb. R.v.p. catalytic gasoline	47.7	55.8
Total 10-lb. R.v.p. gasoline	55.4	65.7

TABLE 2—YIELDS, OKLAHOMA GAS-OIL CHARGE

Conversion, vol. % gas-oil disappearance	70
Yields, vol. %:	
Debutanized gasoline	50.5
Light cycle oil	25.0
Heavy cycle oil	5.0
Butylenes	6.0
Isobutane	5.2
n-Butane	1.7
Propane, propylene, ethane, ethylene, total wt. %	7.8
Combined feed ratio, by volume	1.66
Catalyst-to-oil ratio:	
On raw oil	19.1
On combined feed	11.3
Weight hourly space velocity:	
On raw oil	6.2
On combined feed	9.5



Houdriflow

HOUDRIFLOW catalytic cracking is a continuous moving-bed process. It produces excellent yields of motor gasoline with octanes ranging from 88 to 94 F-1 clear (95-99 with 3 cc. TEL) depending upon operating conditions, charge stock, and catalyst used in the unit. Either synthetic or natural catalysts may be used.

Any fraction of the crude boiling between naphtha and penetration asphalt may be used as feed. Sweet or sour stocks are handled equally well.

Feed may be either liquid, vapor, or a mixture of both. In some units, the reactor feed is totally liquid, although in most plants it is 50% vapor and 50% liquid.

Process characteristics. Here are the outstanding characteristics of Houdriflow catalytic cracking:

1. Sweet and sour crudes are handled equally well.
2. Charge stocks may be a wide range of petroleum distillates lying between naphtha and penetration asphalt.
3. Charge may be fed to the unit as a liquid, vapor, or mixture.
4. Conversion above 90% may be achieved with relatively low coke laydown by a recycle ratio of 1 to 1 or slightly higher. With once-through cracking, conversions of 50-60% are obtained.
5. Operations are stable under normal or emergency conditions.
6. Operating and maintenance costs are low.
7. Operation may be heat balanced thus eliminating need for cooling coils to remove regeneration heat from the kiln.
8. The integrated catalytic reactor and regeneration kiln are self-supporting, as well as the hot catalyst storage bin. These two vessels are usually placed on opposite sides of a steel structure which supports the catalyst lift. The entire Houdriflow unit may be built on a 40-by-60-ft. plot.

Operating conditions. Normal ranges include:

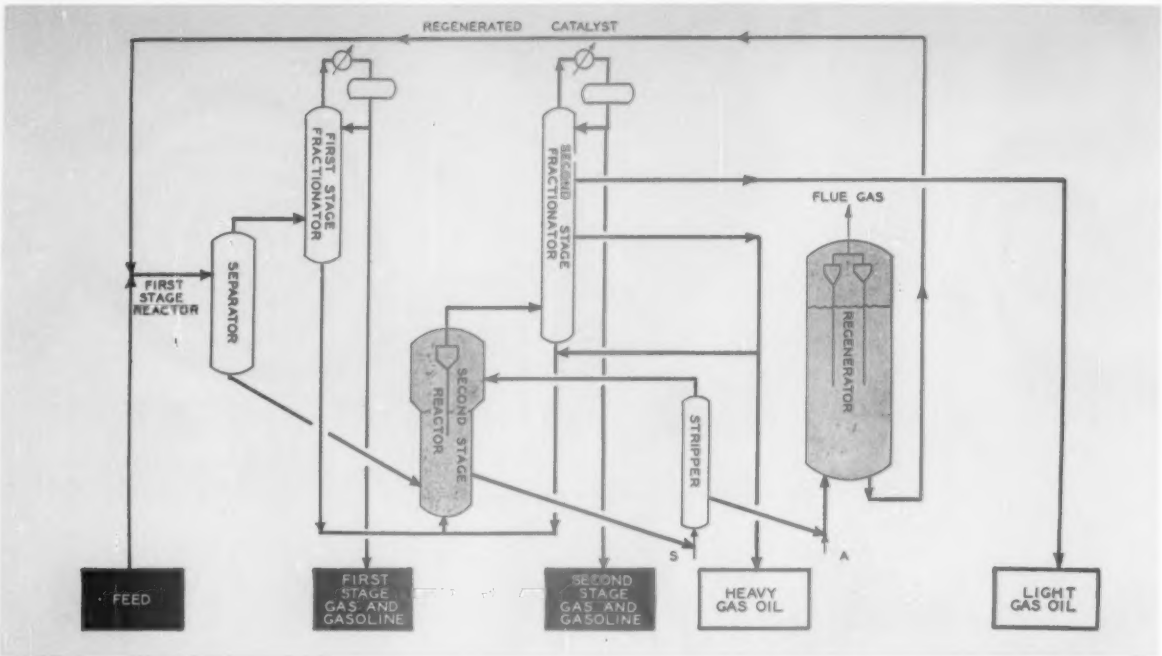
Temperature, 850°-950° F.; pressure, 9-10 psig.; space velocity 1.5-4 vol./hour/vol. Catalyst-to-oil ratio, 3/7.

Twenty-two units ranging in size from 2,000 to 27,000 bbl. per stream day design capacity have been licensed in the U. S. and abroad. Nominal design capacity of all Houdriflow catalytic cracking units in operation and under construction is 280,430 bbl. per stream day.

Typical Yields

Charge stock	A	B	C
Charge rate, b.p.s.d.[1]:			
Virgin gas oil	5,810	4,460	4,750
First pass cat. gas oil	1,430	....	....
Recycle	....	2,200	5,700
Total charge, b.p.s.d.	7,240	6,660	10,450
Conversion	49.7	68.9	90.8
Products:[2]			
Gasoline, vol. %	40.8	53.7	67.8
Total gas oil, vol. %	50.3	31.1	9.2
C_3-C_4 recovered, vol. %	16.1	18.6	25.0
Liquid recovery, vol. %	107.2	103.4	102.0
Fuel gas, wt. %	3.8	5.8	7.3
Catalyst deposit, wt. %	5.2	5.4	9.0
Gasolines octanes:			
F-1 clear	91.5	90.6	89.3
F-1 + 3 cc. TEL	97.5	97.0	96.7
F-2 clear	81.7	...	...

1. Charge stocks are atmospheric plus vacuum gas oils from (A) Texas pipeline crude, (B) Scurry crude, and (C) Hutchinson-Moore County, West Texas, crude.
2. Gasoline basis: 10-lb. R.v.p. and 380° F. at 90% distilled.



Two-stage fluid catalytic cracking

THE TWO-STAGE fluid catalytic cracking process cracks the charge in two stages, instead of in the conventional single stage.

Objectives. When cracking is carried out in a single stage, the less-refractory components are generally cracked too severely to gas and coke; the more refractory components are cracked too lightly to yield desirable products. Both conditions lower the yield of desirable products that otherwise might be obtained.

Two-stage cracking improves this condition by effecting a relatively light cracking in the first stage. After the resulting cracked products are removed, more severe cracking is then effected on the remaining, more refractory components.

By this technique, higher gasoline yield and lower coke make are realized. The cracking process also is given greater flexibility for shifting production between maximum gasoline and maximum intermediates.

Process flow. As shown in the flow diagram, feed and hot regenerated catalyst flow concurrently up through the first-stage riser reactor in which the retention time is very short. Temperature in the riser reactor is held at a high level in order to reduce the coke yield.

The effluent mixture passes to a high-load separator where the partially spent catalyst is removed from the hydrocarbon products of the first cracking stage. The latter then go to a fractionator where the less-refractory product hydrocarbons are separated. The bottoms are sent to the second stage for a longer, more thorough cracking.

In the second stage the partially spent catalyst again contacts the hydrocarbons. The fact that the catalyst is partially spent does not hamper its efficiency in this stage.

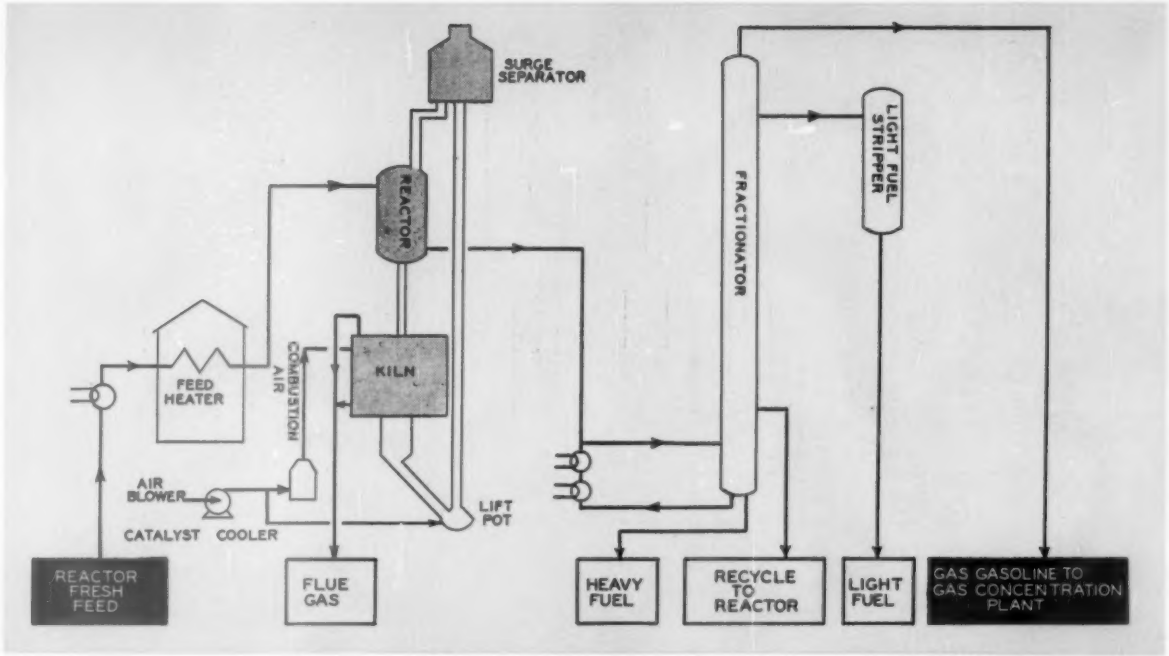
Principles of this process can, in some instances, be applied to existing fluid cat cracking units. Modification involves addition of a riser reactor and accompanying facilities.

Results. Typical products of two-stage fluid catalytic cracking of feeds prepared from Alberta, Ventura, and Four Corners crudes are given in the table.

First commercial unit using the two-stage technique was built in Shell Oil Co.'s Anacortes, Wash., refinery. The process is licensed by Shell Development Co. through M. W. Kellogg Co. and Universal Oil Products Co.

FEED STOCK AND YIELD DATA

	Alberta		Ventura		Four Corners
	1	2	1	2	1
Type of Feed Stock:					
Charge rate, bbl. per day	20,000	30,000	20,500	18,000	21,000
Feed-Stock Properties:					
API gravity	26.5	27.1	25.0	24.5	28.6
Engler distillation,					
°F. I.b.p.	505	500	457	436	400
10%	610	575	565	550	473
Pour point, °F.	+65	+70	+70	+75	0
Ramsbottom carbon residue, wt. %	0.82	0.69	0.39	0.59	0.60
Sulfur, wt. %	0.80	0.75	0.86	0.78	0.39
Cracking yields, vol. %					
Ethane and lighter, (wt. %)	3.8	3.8	4.9	6.2	3.2
Propylene	10.3	7.8	8.5	8.5	10.2
Propane	3.5	3.9	3.1	2.6	2.8
Butylenes	12.9	10.3	11.0	10.8	12.3
Isobutane	5.3	3.0	4.2	2.6	8.4
Normal butane	1.2	0.7	0.8	1.3	1.3
Debutanized 450° F. cut-point gasoline	53.6	51.5	44.7	48.2	52.0
Light gas oil	11.3	18.2	15.5	10.8	11.0
Heavy gas oil	9.4	11.3	15.4	13.1	10.2
Coke, wt. %	8.7	6.9	9.9	12.1	8.4
10-lb. R.v.p. gasoline (incl. C_5 and C_4 polymer)	75.6	67.1	62.8	66.4	73.0
Conversion, wt. %	78.6	69.9	69.6	74.7	78.1



Airlift Thermofor catalytic cracking

THE AIRLIFT Thermofor catalytic cracking (TCC) process is a modern, moving-bed cracking process for converting gas oils to gasoline, and for reducing over-all fuel-oil production. Light hydrocarbons for petrochemical manufacture, alkylation, and LPG are valuable byproducts.

Modern units. The modern Airlift unit has catalyst coolers (steam generators) which allow close control of reactor operating conditions, regardless of variations in charge stock and carbon laydown. Other major improvements in equipment, as well as in the catalyst, have greatly reduced investment, maintenance, and operating costs, and at the same time provide greater flexibility.

They are carefully designed to provide optimum initial contact between the oil charge and the catalyst in the reactor, and uniform cracking thereafter. Use of a moving solid bed of catalyst in the reactor keeps "channeling" and "back-mixing" of cracked vapors to a minimum.

The result is very little undercracking or overcracking. High conversions can therefore be obtained at relatively low reactor temperatures. Products are more stable, and contain fewer olefins and more isoparaffins. Liquid recoveries are high, and dry gas and coke are minimized.

Operating conditions. Typical cracking conditions are: Reactor space velocity, 1 to 2.5 volume per hour per volume; catalyst-to-oil ratio, 2 to 5 (volume); recycle-to-fresh-feed ratio, 0 to 2 (volume); and average reactor temperature, 840° to 950° F. These conditions can be varied as required to suit a wide range of feed stocks and product distributions.

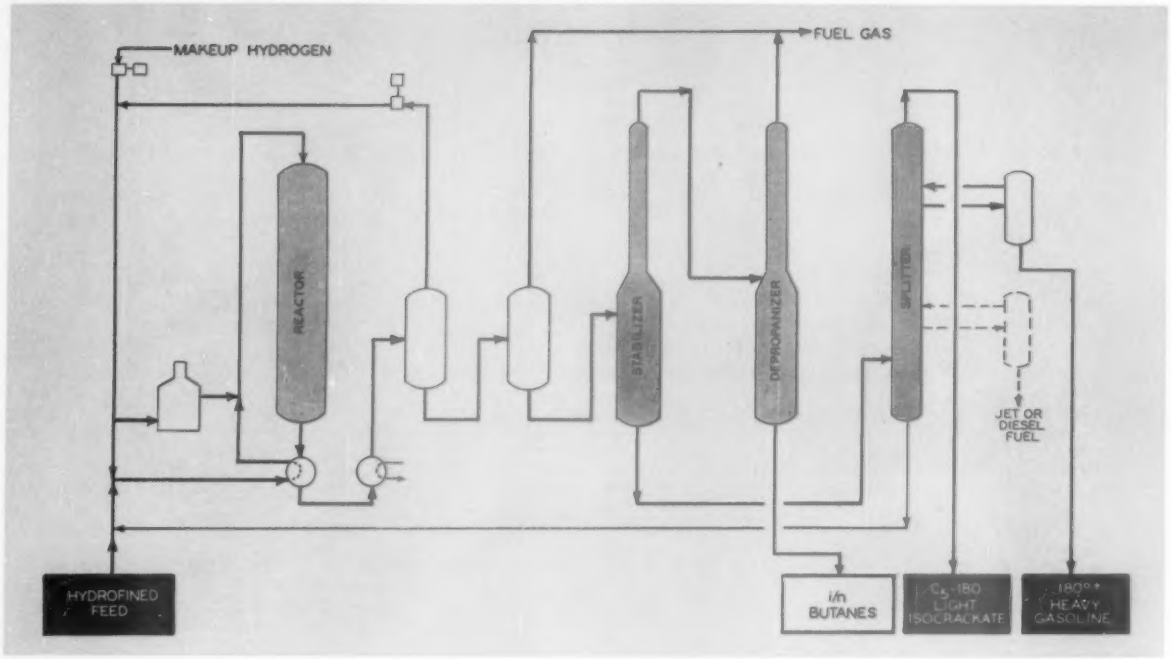
Operation. The Airlift TCC unit is easy to start up and keep on stream. Automatic controls have been developed to operate the airlift at optimum velocity, minimizing catalyst attrition. With the new synthetic-bead catalyst (Durabead), makeup ranges between 0.10 and 0.15 lb. of catalyst per barrel of feed. Yield data on commercial units are given in the table.

Investment costs, excluding gas-concentration facilities, range between $150 and $280 per barrel of total feed, depending on unit size, charge stock, and conversion level. Annual maintenance cost (materials and supplies) is about 1.5% of investment.

Commercial data. Units on stream range in capacity from 1,600 to more than 33,000 bbl. per stream day. Total capacity of units operating and under construction amounts to well over 800,000 bbl. Majority of these Airlift TCC units are being operated by licensees, in all sizes of refineries and on every continent. For further information, contact the Process Promotion Department, Socony Mobil Oil Co., New York.

FIELD DATA FROM COMMERCIAL UNITS

Crude Gas-oil type—	Kansas atmos., vacuum	Mississippi atmos., fluid coker	Texas atmos.,deasph.
Yields:			
Gasoline, vol. %	56.3	54.8	63.4
Light cycle, vol. %	15.0	10.5	2.8
Heavy cycle, vol. %	17.0	6.7	6.3
Butanes, vol. %	10.8	15.7	21.1
Propanes, vol. %	8.8	17.7	12.3
Ethane and lighter, wt. %	2.3	4.4	5.3
Coke, wt. %	5.2	10.6	9.3
Properties:			
Charge-stock gravity, °API	26.5	21.8	31.0
10%, °F.	657	460	661
50%, °F.	835	600	894
90%, °F.	1,021	900	1,037 @ 70%
Gasoline, R.v.p.	10.5	7.5	7.8
10%, °F.	137	133	127
50%, °F.	230	225	229
90%, °F.	395	347	389
F-1 octane, + 3 ml, TEL	97.2	98 (Est'd.)	96.8



Isocracking

ISOCRACKING is a catalytic hydrocracking process; that is, cracking in the presence of hydrogen and a catalyst.

Applications. Because of the process's versatility, a given plant can be used for many different applications. These include: (1) increasing refinery realization by converting marginal gas oils into premium-quality light products, (2) improve cat cracker efficiency and relieve bottlenecks, (3) provide flexibility to change the refinery-product slate to meet seasonal demand, (4) improve middle-distillate product quality, including pour-point reduction and cetane improvement, (5) make light isoparaffins to balance alkylation requirements, (6) reduce bunker fuel-oil production.

Isocracking efficiently converts cracked or straightrun hydrocarbon distillates to over 100% yield of high-octane gasoline. Alternately it can be used to produce gasoline, plus low-freeze-point jet fuel, burner oil, or high-cetane diesel fuel of low pour point. As a byproduct, the process also makes 5 to 15% yields of isobutane, and can be operated to produce large quantities of isopentane and isohexane.

Operation is flexible both as to feed stock and end products. As indicated on the flow sheet, feed stocks normally require hydrofining for removal of nonhydrocarbon impurities. The plant can run to extinction recycle to make variable end-point products, or to 50-90% per pass conversion on a once-through type operation to make gasoline and upgraded middle distillates.

Operating conditions. The operating pressure for isocracking ranges from 500 to 1,500 psig. Temperatures range from 400° to 700° F. Hydrogen consumption ranges from under 1 M.s.c.f., for once-through operation on hydrofined light feeds, up to about 1,800 std. cu. ft. per bbl. for heavy feeds converted to low-end-point products. Gas yields are typically low and can be considered negligible.

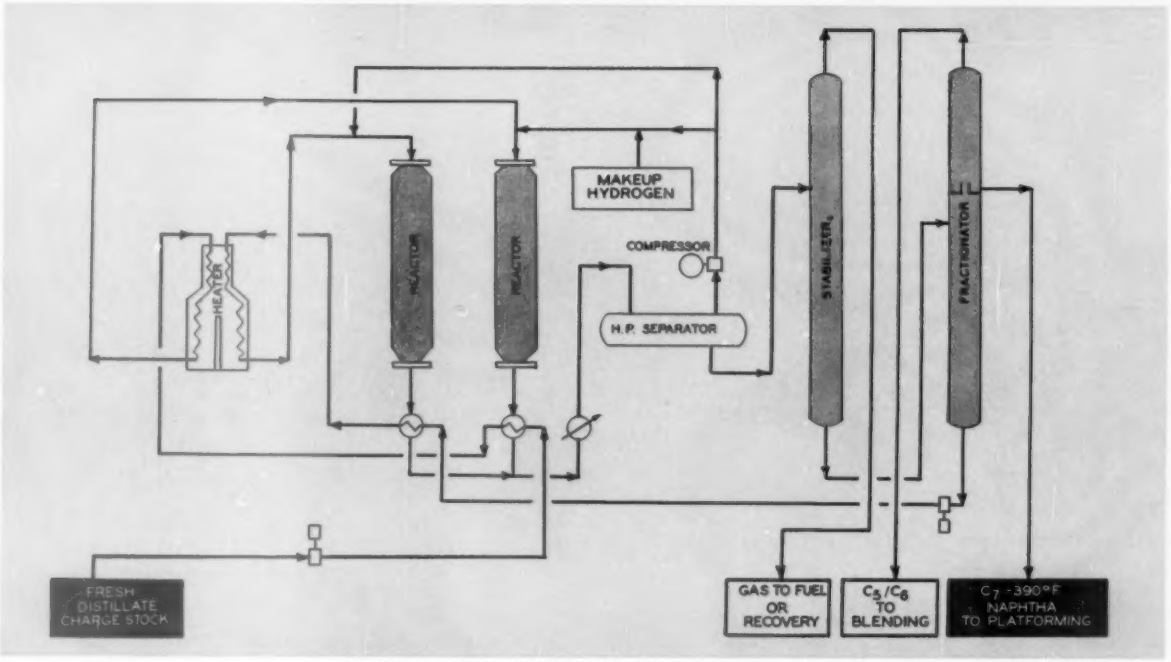
Products. Yields from typical feed stocks are given in the table. Other eligible feed stocks include: Gas plant condensates, waxy distillates, raffinates, and heavy naphthas.

YIELDS FROM TYPICAL FEED STOCKS

	Light catalytic cycle oil	Light coker distillate	S.R. gas oil	Heavy catalytic cycle oil
Typical Inspections				
Gravity, °API	26.0	24.8	29.1	19.0
Aniline point, °F.	111	80	177	81
Boiling range, °F.	400-650	350-650	540-805	400-850
Products, vol. %				
Isobutane	11.4	14.0	8.1	11.8
n-butane	5.9	6.1	3.3	5.1
C_5-180° F.	27.1	28.5	21.6	27.3
180-400° F.	78.3	72.8	...	83.1
180-320° F.	...	...	40.9	...
320-525° F.	...	...	44.6	...
	122.7	121.4	118.5	127.3

Isocracking products have uniform high quality. They are essentially free of sulfur, nitrogen, and olefins and are water white. The C_5 to 180° F. light isocrackate has both F-1 and F-2 leaded octane ratings of 99 to 101, irrespective of the type of charge stock. The heavy isocrackate is premium new catalytic reformer charge stock that did not exist in the refinery before its creation in isocracking.

Commercial installations. The first commercial unit was placed on stream in the Richmond, Calif., refinery of Standard Oil Co. of California in July 1959. A 7,500-bbl. per day Isocracker for Standard Oil Co. (Ohio) at Toledo, and a 20,000-bbl. unit for Tidewater Oil Co.'s Avon, Calif., refinery have been announced. Information about Isocracking may be obtained from California Research Corp., San Francisco, Calif.



Lomax

THE LOMAX PROCESS offers a highly flexible method of hydrocracking in the presence of a catalyst to convert light distillates into gasoline. Heavier distillates, including vacuum gas oils and catalytic cycle oils, are converted into high-quality middle distillates and gasolines.

An attractive feature of the latter application is the ability of the process to either maximize the conversion of the charge stock into gasolines, or to suppress this in favor of middle distillates when desired.

Middle distillates need no further refining before they are blended into salable products. To meet the requirements of premium and superpremium gasolines, the heavy naphtha should be reformed. However, this step may not be required if the naphthas are to be used in regular gasoline.

. . . **Products** of the Lomax process are characteristically very low in olefins, as compared to conventional catalytic cracking. A much smaller quantity of light-hydrocarbon gases is produced, also. The light naphtha—butanes, pentanes, and hexanes—is predominantly branched chain in nature. Aromatics in the charge stock can be either saturated or substantially retained by appropriate selection of operating conditions.

Process flow. The process employs fixed beds of catalyst and operates under hydrogen pressure. The schematic flow diagram illustrates the conversion of a distillate stock into gasoline.

Heated charge is mixed with hydrogen and enters the reactor where partial conversion occurs. Effluent is separated from the unconsumed hydrogen, debutanized in a conventional stabilizer, and the bottoms product fractionated to C_5-C_6 hydrocarbons overhead and a C_7-to-end-point naphtha sidecut.

Fractionater bottoms product is reheated to reaction temperature, remixed with hydrogen, and processed in another reactor. Effluent from this reactor is combined with that from the first reactor for the stabilization and fractionation steps.

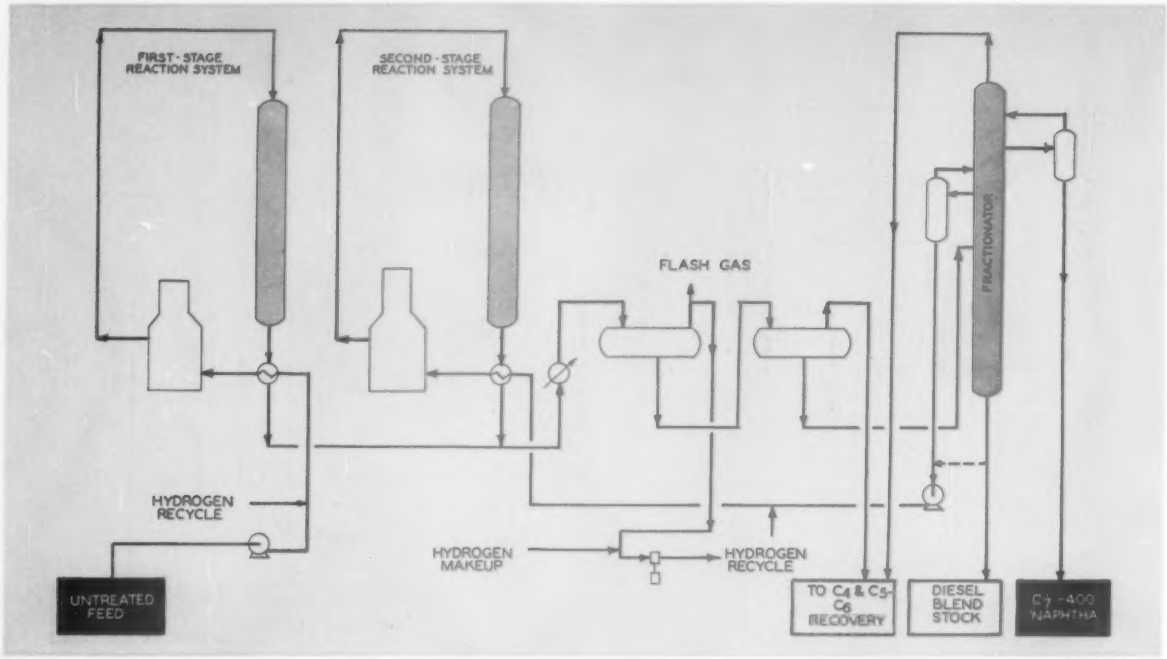
When it is desired to process the heavier distillates and produce middle distillates in addition to gasoline, the fractionation system is modified accordingly. Heavy, unconverted ends are still returned to process, however.

Yield data. The table presents data from the pilot plant processing of a Wyoming-West Texas vacuum gas oil to maximize middle distillates. The charge stock has an API gravity of 21.6 and boils between 590° and 920° F.

Commercial data. One commercial Lomax unit is under construction. It is designed to produce 2,537 bbl. per stream day of C_4-plus gasoline from 2,200 bbl. per stream day of a blend of 440°-656° F. diesel fuel and 200°-425° F. thermally cracked naphtha. The process was originated by Universal Oil Products Co. which will license it.

LOMAX USED TO MAXIMIZE MIDDLE DISTILLATE PRODUCTION

Fraction	C_5-C_6	220°-400° F.	400°-525° F.	400°-650° F.
Vol. % of fraction	4.0	26.0	38.0	78.0
Gravity, °API at 60° F.	...	52.0	39.5	37.5
Engler distillation:				
I.b.p., °F.	...	226	405	425
10%	...	280	420	468
50%	...	320	441	530
90%	...	359	480	610
E.p.	...	398	520	653
Hydrocarbon types, vol. %:				
Paraffins	...	41	} 88	...
Napthenes	...	51		
Aromatics	...	8	12	...



Unicracking

UNICRACKING is a catalytic hydrocracking process for efficiently and economically upgrading marginal and problem cracking stocks, including catalytic cycle oils; virgin, thermal, and coker gas oils; and heavy cracked or straight-run naphthas.

Objectives. The highly versatile process converts gas oils to gasoline stocks, or to any desired proportions of gasoline stocks and high-quality midbarrel stocks. Liquid product yield is generally from 110 to 125 vol. % of feed, depending upon the particular feed stock and the products desired. Methane, ethane, and coke yields are almost negligible; no fuel oil is produced.

Description. Unicracking is a fixed-bed process which requires infrequent catalyst regeneration. Two stages of cracking are generally used as shown on the flow sheet. Untreated feed is introduced directly into the first stage, where 30-50% of the feed is converted to gasoline. Reactor effluents from both stages are combined, and after appropriate cooling and liquid-gas separation, the liquid enters a common fractionator.

Unconverted oil is the feed to the second reaction stage, and is recycled to meet conversion requirements. Second-stage conversion to gasoline is 50-70% per pass. Unconverted gas-oil boiling-range material is upgraded to high-quality jet fuel or diesel fuel.

Depending upon the feed stock and the objective, reactor temperatures range from 500° to 800° F. Operating pressures vary from 500 to 2,000 psig. Conventional refining equipment is used throughout.

Products. The C_4, C_5, and C_6 fractions contain a high percentage of high-octane isoparaffins. The C_5-C_6 fraction has an octane rating of 99 to 100, F-1 and F-2 leaded, from all types of charge stocks.

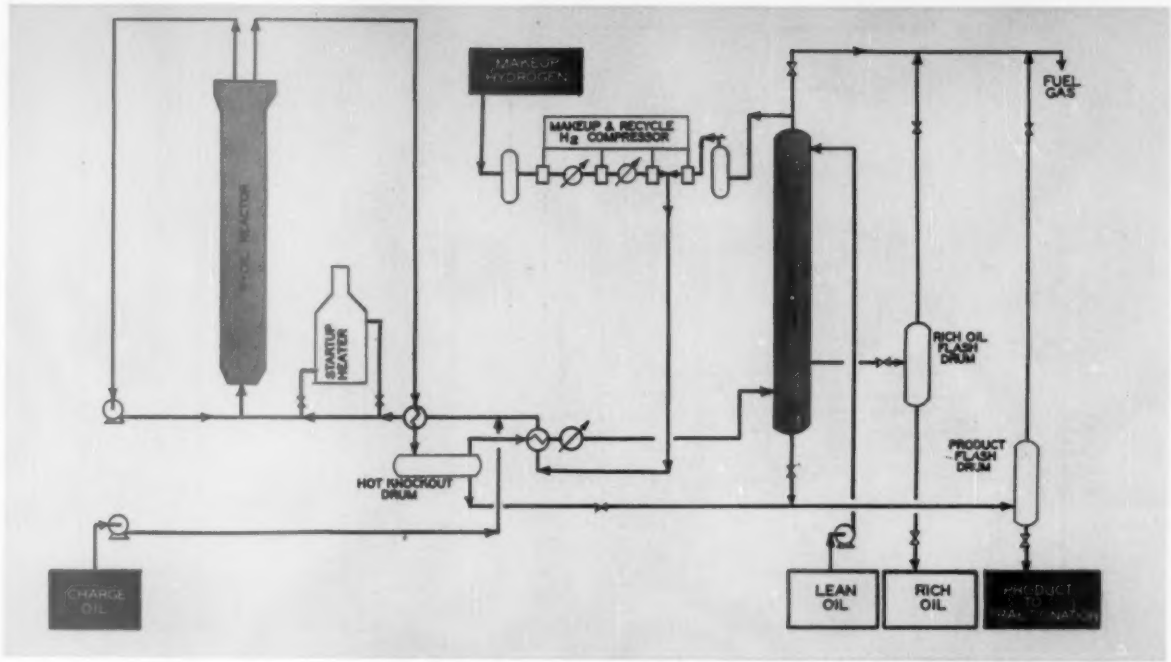
Octane rating of the C_7 —400° F. e.p. Unicracked gasoline increases as aromatic content of the feed increases. This cut is an excellent reformer feed stock requiring no pretreatment, and in some cases may be blended directly to gasoline. Substantial quantities of excellent kerosine-type jet fuel, or high-cetane diesel, may also be produced if required for controlling the extent of cracking.

YIELDS FROM THREE TYPICAL FEED STOCKS

	Catalytic cycle oil	Coker gas oil	St. run gas oil
Feed properties:			
Gravity, °API	25.9	29.7	28.6
Boiling range, °F.	450-580	390-600	600-770
Aromatics, wt. %	53	31	20
Sulfur, wt. %	1.17	1.75	2.27
Nitrogen, p.p.m.	70	1,340	420
Product yields, vol. %:			
Isobutane	7.7	9.4	4.3
n-Butane	5.2	5.4	2.7
C_5-C_6	23.0	26.0	12.8
C_7-400° F.	71.7	76.2	...
C_7-340° F.	...	...	23.9
340°-516° F., jet fuel	...	...	71.0
Diesel stock	10.7	...	...

Economics. Basis for the following costs are: light catalytic cycle-oil feed stocks, hydrogen supply from catalytic reforming, four-product fractionation, and initial catalyst charge. Cost of the hydrogen is not included. Further information on Unicracking may be obtained from Union Oil Co. of California.

Unit charge, b.p.s.d.	5,000	15,000	15,000
Conversion, vol. % fresh feed	90	90	70
Capital investment, dollars per bbl. of feed	600-750	470-550	400-480
Direct operating costs, cents per bbl.:			
Operating labor	3.9	1.9	1.9
Utilities	13.6	13.6	11.2
Catalyst	5.0	5.9	5.1
Maintenance	9.0	6.7	5.7
Total direct cost	32.4	28.1	23.9



H-Oil process

THE H-OIL PROCESS reacts hydrogen with various petroleum stocks in the presence of an active catalyst to remove sulfur, nitrogen, and organo-metallic compounds, simultaneously upgrading the stocks treated.

The process is particularly applicable to the refiner who needs to improve his furnace and diesel oils, or who has residual stock which can be upgraded profitabily to more valuable distillate products.

Process features. The flow diagram applies to heavy gas-oil and residum charge stocks. It is modified somewhat for treatment of lighter distillate stocks.

In processing heavier stocks, hydrogenation of the charge oil is highly exothermic. Thus the reactor can be maintained at the desired operating temperature without additional feed preheating. The heater provided for startup is blocked from the high-pressure circuit when the reactor has reached operating temperature.

The absorber removes light hydrocarbons from the recycle-hydrogen stream, thus maintaining a high hydrogen partial pressure. Rich oil from the absorber is flashed and stripped of light ends before reuse as lean oil. Lighter distillate stocks do not require absorption facilities since the light-gas make it usually small.

Bulk of the H-Oil product is condensed in a hot drum to conserve heat for subsequent product fractionation. The remainder is condensed by water cooling.

Catalyst features. An ebullating catalyst bed permits operation with catalyst sizes down to 1/32-in. extrudats, without being limited by pressure-drop difficulties. The small size offers the advantage of greatly increased activity because of the greater effective surface area.

Another feature is the ability to maintain an essentially isothermal bed, even with the high heat release experienced with deep hydrogenation and desulfurization.

The process is licensed by Hydrocarbon Research, Inc.

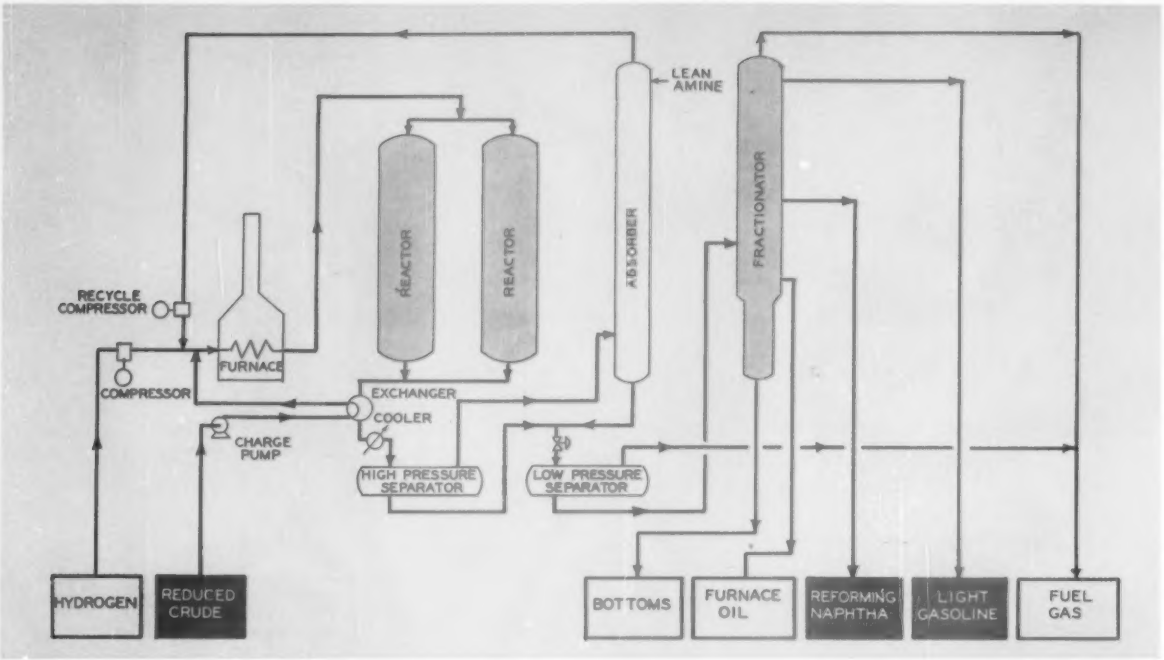
TABLE 1—TYPICAL YIELDS

Charge	Kuwait residuum	Boscan crude	West Texas vacuum residue: Moderate conversion	West Texas vacuum residue: High conversion
Gravity	8.3	10.5	10.4	10.4
Sulfur, wt. %	5.3	5.5	3.1	3.1
Ramsbottom carbon, wt. %	17.2	15.5	15.7	15.7
Hydrogen consumption				
Std. cu. ft. per bbl. of charge	1,500	950	900	1,100
Product yields				
C_1—C_3 wt. %	3.3	3.8	2.4	4.1
C_4's yield, vol. %	2.5	2.5	1.6	2.4
Gasoline (C_5-400° F.)				
Yield, vol. %	19.8	18.0	11.1	20.5
Gravity, °API	53.5	56.6	57.7	56.0
Sulfur, wt. %	Negligible	<0.10	0.05	0.10
Aniline point, °F.	130	128	129	127
Bromine no.	2.0	....	6.4	17
Furnace oil (400°-650° F.)				
Yield, vol. %	24.0	26.0	20.7	29.3
Gravity, °API	34.7	34.9	32.5	33.2
Sulfur, wt. %	0.05	0.50	0.15	0.16
Aniline point, °F.	136	127	138	137
Bromine no.	5.0	....	9.0	12.0
Heavy Gas Oil (650°-975° F.)				
Yield, vol. %	29.1	42.0	35.4	33.4
Gravity, °API	21.7	21.7	21.2	20.5
Sulfur, wt. %	0.64	1.02	0.45	0.70
Residue (975° F+)				
Yield, vol. %	29.4	15.5	36.0	19.5
Gravity, °API	9.1	2.0	9.5	6.6
Sulfur, wt. %	2.52	2.43	1.85	2.22

TABLE 2—INVESTMENT & OPERATING COST, FOR A 5,000-BPSD UNIT

Investment	$2,400,000
Operating cost (cts./bbl. feed)	
Utilities	8
Catalyst	2-5*
Labor and supervision	4
Total	14-17

*Dependent on charge stock.



HDS process (Gulf)

GULF HDS, a hydrogenation process, at intermediate pressures can effectively reduce viscosity and desulfurize high-sulfur residual stocks. At somewhat higher pressures, it can completely eliminate residual production by converting the charge to catalytic cracking stocks which are equal or superior to virgin gas oils.

An available commercial catalyst permits effective onstream cycles up to 6 months, depending upon operating pressure and type of charge. Essentially all metals in the oil are deposited on the catalyst at the higher operating pressures. Thus occasional washing of the catalyst after regeneration is required with residual stocks having a high metals content. Regeneration is carried out by a mixture of steam and air heated to about 750° F. A catalyst life of at least 2 years is normally expected.

Products. Product naphtha is suitable in some instances as a direct reformer feed stock, or it may require further processing to remove nitrogen. The furnace oil is a finished product of excellent quality. Bottoms product is either premium catalytic cracking charge stock or a high-quality, low-sulfur-content heavy fuel oil, depending upon the degree of hydrogenation used.

Yields and inspections for applications of the HDS process to vacuum and atmospheric reduced Kuwait residues are summarized in the table.

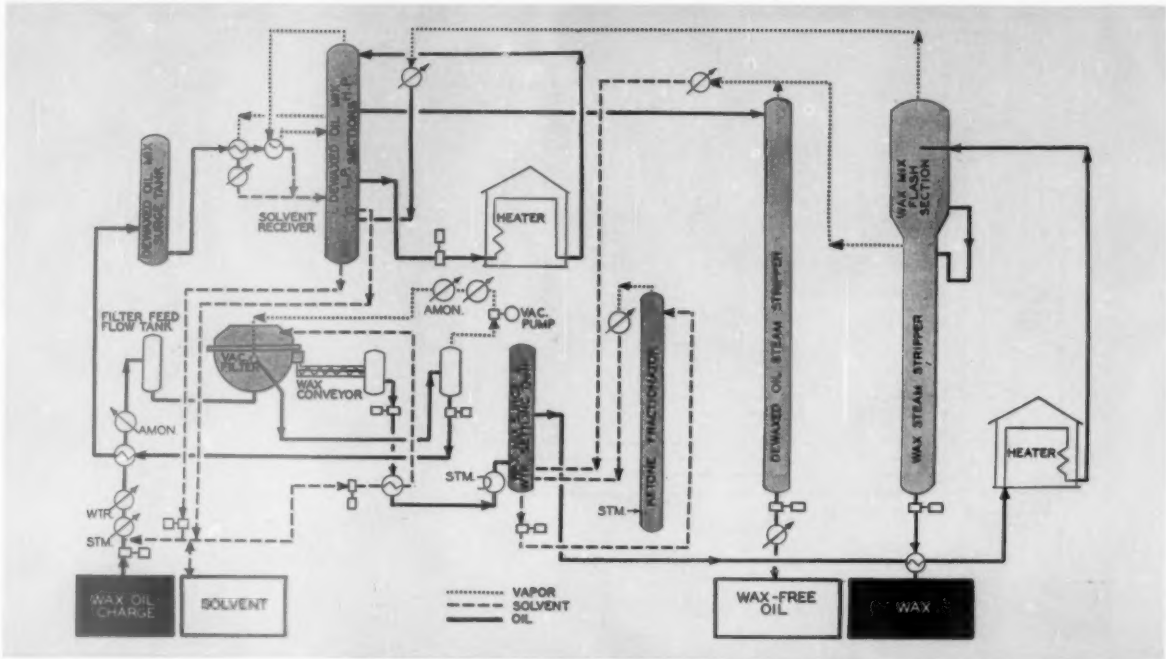
Operating conditions. Feed-stock properties and the hydrogen-treating severity desired determine operating conditions. Temperature is normally maintained in the range of 750°-850° F. Pressure usually is between 500 to 3,000 psig. Suitable desulfurization and conversion usually can be obtained at space velocities in the range of 0.5 to 2.0 vol. per hour per vol.

Recycle gas rate is controlled between 2,000-10,000 std. cu. ft. per bbl., with a hydrogen concentration between 65 and 90%. Hydrogen consumption varies from 45 to 1,200 std. cu. ft. per bbl., depending upon the conditions used and the nature of the feed stock.

Economics. Process economics to a large extent depends not only on a particular refiner's situation, but also upon the condition of the residual-fuel-oil market. At the present price structure the HDS process pays out more rapidly than visbreaking as a method for processing high-sulfur residues. With the continuing trend toward improved-quality products, benefits offered by the process are a significant competitive advantage. Further details on the process, developed by Gulf Research & Development Co., may be found in The Oil and Gas Journal, March 28, 1960, p. 130.

HDS PROCESSING OF KUWAIT RESIDUES

Charge	18% vacuum reduced crude	44% atmospheric reduced crude
Operating pressure	1,000 psig.	3,000 psig.
Charge stock:		
Gravity, °API	5.5	13.7
Sulfur, %	5.5	4.1
Viscosity, S.U.v. at 210° F.	22,130	277
Carbon residue, %	23.1	9.6
Vanadium, p.p.m.	102	49.5
Product inspection:		
Gasoline (I.b.p.-400° F.)		
Yield, by vol.	5	2
Sulfur, %	0.17	0.04
Aromatics, %	15.0	16.2
Naphthenes, %	21.1	32.1
Furnace oil (400°-650° F.)		
Yield: % by vol.	20	12
Gravity, °API	33.7	34.6
Sulfur, %	0.2	0.05
Diesel index	43.6	40
Residue (650° F. +):	Fuel oil	FCC charge
Yield: % by vol.	76	88
Gravity, °API	13.0	23.1
Sulfur, %	1.0	0.27
Carbon residue, %	14.6	2.9
Viscosity, S.F.s. at 122° F.	200	...
Total nitrogen, %	....	0.114
Vanadium, p.p.m.	13.2	<0.1
Nickel, p.p.m.	....	0.3
Characterization factor	....	12.07



Solvent dewaxing

THE SOLVENT DEWAXING process uses a mixture of solvents to produce dewaxed oils with pour points approximately equal to the dewaxing temperature. The wax produced has a highly crystalline structure and thus is easily filterable.

Oils ranging from low-viscosity distillates to highly viscous residual stocks are readily dewaxed, irrespective of wax type. The oils may be either unrefined or refined prior to dewaxing.

Outstanding characteristics of the process are its simplicity of operation, great flexibility, relatively low construction and operating costs, and ability to produce high yields of dewaxed oils and waxes of very low oil content. No special equipment or alloys, high pressures, or excessively low operating temperatures are required.

Process description. Mixtures of aromatic solvents such as benzol or toluol, plus a polar solvent such as acetone or methyl ethyl ketone, are mixed with the waxy oil. The stream then is charged to conventional double-pipe exchangers and chillers (see diagram). Solvent-to-oil ratios vary from about 1:1 to 4:1.

From the chillers the mixture flows into a filter feed tank and then into totally enclosed drum-type vacuum filters for separation of the wax from the oil-solvent solution. Steam is used to remove the last traces of solvent from the oil. Steps also are taken to recover all solvent from the wax.

The wax cake on the filters is washed continuously with cold solvent to displace any oil-solvent mixture remaining. By controlling the amount of solvent and its injection point during chilling, as well as the manner in which the cake is deposited on the filter, the solvent-displacement wash is effective in producing low-oil-content wax.

Yields of dewaxed oil depend on wax content of the charge stock. The cold displacement wash applied on the filter sepaartes oil from wax almost completely.

Because of its relatively low boiling point, the solvent can be recovered. Dewaxed oil and wax solutions are charged to evaporators where the solvent is vaporized and returned to the system.

Product data. Properties of a typical paraffinic-base solvent-refined distillate and the dewaxed oil produced are given in the table. Solvent losses typically average less than 0.03% of the solvent circulated.

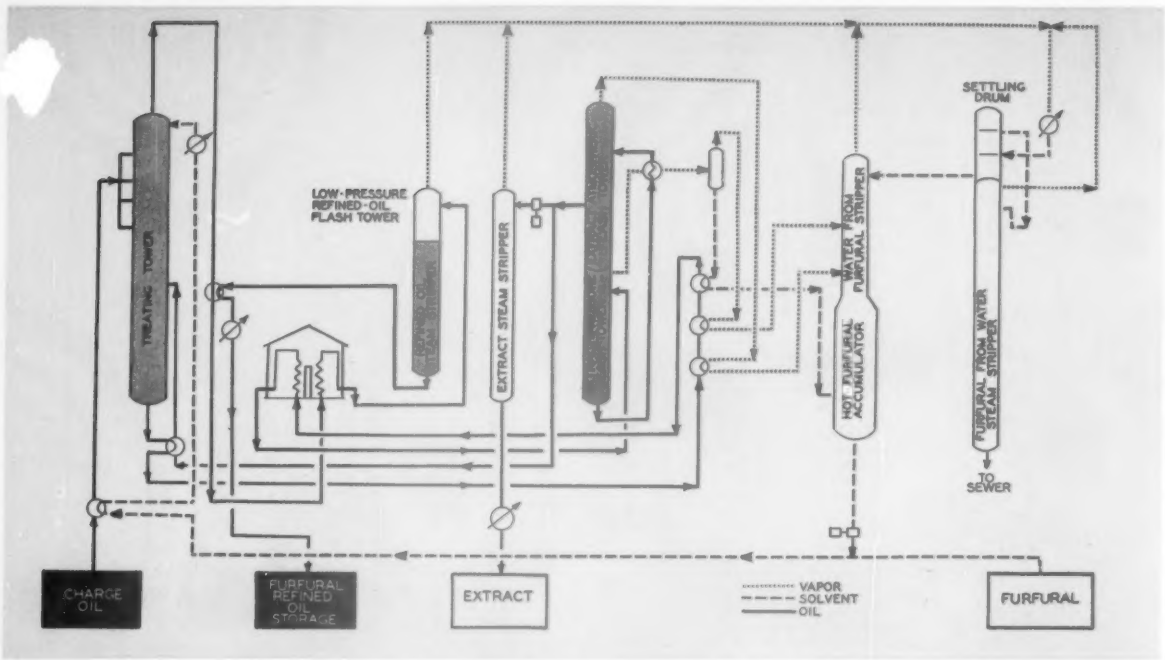
Utility requirements, per barrel of charge stock, are approximately as follows: Steam at 300 psig., 40 lb.; power 12.0 kw.-hr.; cooling water 2,300 gal.; and fuel 290,000 B.t.u. The annual cost of labor and materials for maintenance is about 2% of investment cost. A service factor of 95% can be maintained.

About two-thirds of the chilling of the charge mix is obtained by exchange with the cold dewaxed oil solution. The remaining one-third is supplied by indirect refrigeration, using ammonia or other refrigerants.

Commercial data. The solvent dewaxing process is licensed by Texaco Development Corp. Seventy-eight units have been installed or are under construction.

TYPICAL CHARGE AND PRODUCT DATA

Physical characteristics—	Charge oil	Dewaxed oil
Gravity, °APO	30.6	29.1
Flash, °F. Cleveland Open Cup	420	420
Viscosity S.s.U. at 100° F.	....	182.0
Viscosity S.s.U. at 210° F.	43.5	45.1
Viscosity index	....	95.5
Pour point, ASTM	85° F.	0



Furfural refining

A LIQUID-TO-LIQUID extraction process, furfural refining is used to remove undesirable components from a wide range of distillate and residual petroleum fractions.

Furfural is selective for unstable components of low viscosity indices, for color bodies, resins, carbon-forming constituents, and sulfur compounds. Furfural-refined oil has greatly improved temperature-viscosity characteristics and contains substantially all of the desirable lubricating-oil components present in the charge stock.

The high specific gravity of furfural insures rapid, complete separation of the refined oil and extract phases in extraction towers of relatively small sizes or in other types of extraction equipment. The high critical-solution temperature of furfural permits its use with waxy or viscous oils at temperatures that insure treatment in the nonviscous, liquid-wax range. Furfural is also nontoxic and nonacidic, as well as being available in many countries at low cost.

Process description. Process flow in a furfural refining plant using a packed extraction tower is shown in the diagram. The extraction tower, if used, usually contains separate packed sections. Other types of extraction equipment, such as centrifugal extractors, or a rotating disk and stationary baffles device, are also used in licensed operations.

The raffinate and extract solutions flow directly from extraction through separate heat exchangers to solvent recovery. Final stripping of furfural from the refined product and extract is accomplished by injecting live steam into stripping towers. Any water introduced into the system during stripping is separated from the furfural in a separate fractionating tower.

Operating conditions and utilities depend upon the charge stock and the degree of refining desired. Approximate utility requirements per barrel of feed are:

Steam, at 300 psig., lb.	40
Power, kw.	1.0
Cooling water, gal.	1,000
Fuel, M.B.t.u.	285

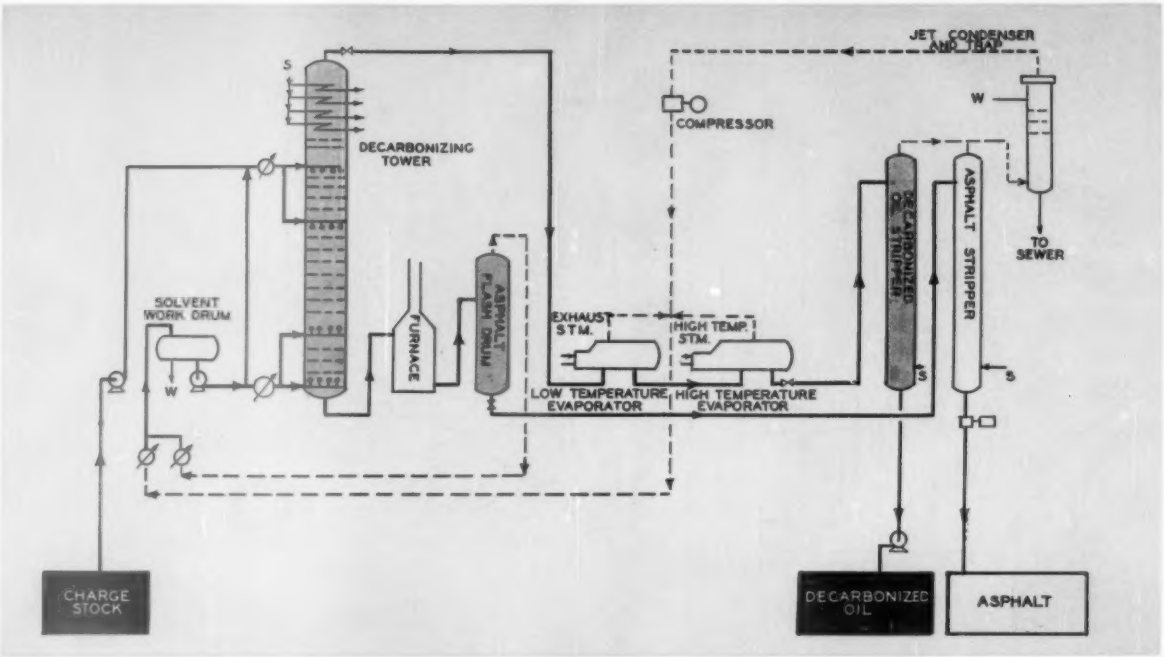
A 3,000-bbl. per stream-day unit may be operated by one man per shift, although two men per shift are normally used. The annual cost of labor and materials for maintenance are about 3% of investment. A service factor of 95% is conventionally maintained. Solvent losses amount to 0.1% of the oil treated.

Yield data. Typical examples of charge stocks and refined products from Mid-Continent crude oils are given in the table.

Commercial data. Fifty-seven plants have been installed for refining lubricating oils using the furfural refining process, which is licensed by Texaco Development Corp.

TYPICAL CHARGE STOCK AND YIELD

Physical characteristics	Distillate	Deasphalted residuum
Charge:		
Gravity, °API	25.4	23.1
Viscosity S.s.U. at 210° F.	69.3	132.6
Con. carbon residue, wt. %	0.52	1.42
Raffinate:		
Gravity, °API	30.9	29.6
Viscosity S.s.U. at 210° F.	58.4	102.3
Con. carbon residue, wt. %	0.03	0.20
Viscosity index (dewaxed to 0° F. pour)	96	95
Extract:		
Gravity, °API	9.5	13.9



Solvent decarbonizing

SOLVENT DECARBONIZING is a liquid-liquid extraction process for recovering heavier paraffinic fractions from distillation residues.

Objective. The process allows the refiner to increase gasoline and other light-product yields at the expense of fuel oil. Operating on atmospheric or vacuum reduced crudes as feed, the products are a premium catalytic cracking feed stock and a virgin asphalt. The latter, if from a suitable crude, may be blended to paving specifications.

Supplementing distillation, the process recovers some 40 to 75% of profitable catalytic feed stock from residues which would otherwise go to fuel or thermal cracking. Since the over-all result is an increase in catalytic gasoline and a decrease in thermal gasoline, solvent decarbonizing offers a potential increase in octane numbers.

Process flow. Solvent decarbonizing is a low-temperature extraction process, using pure (or mixed) low-molecular-weight, paraffinic hydrocarbons as liquid solvents.

As shown in the flow diagram, temperature of the feed is adjusted to the desired level, and then charged to the decarbonizing tower. Solvent, introduced near the bottom of the tower, is contacted countercurrently with descending heavy oil. Steam coils, near the top of the tower, raise the temperature of the ascending phase to induce reflux. This maximizes selectivity of the separation.

Decarbonized oil solution is withdrawn overhead and heated under pressure to evaporate the solvent. Most of the heat comes from exhaust steam. Last traces of solvent are removed by direct contact with steam at low pressure in the decarbonized oil stripper.

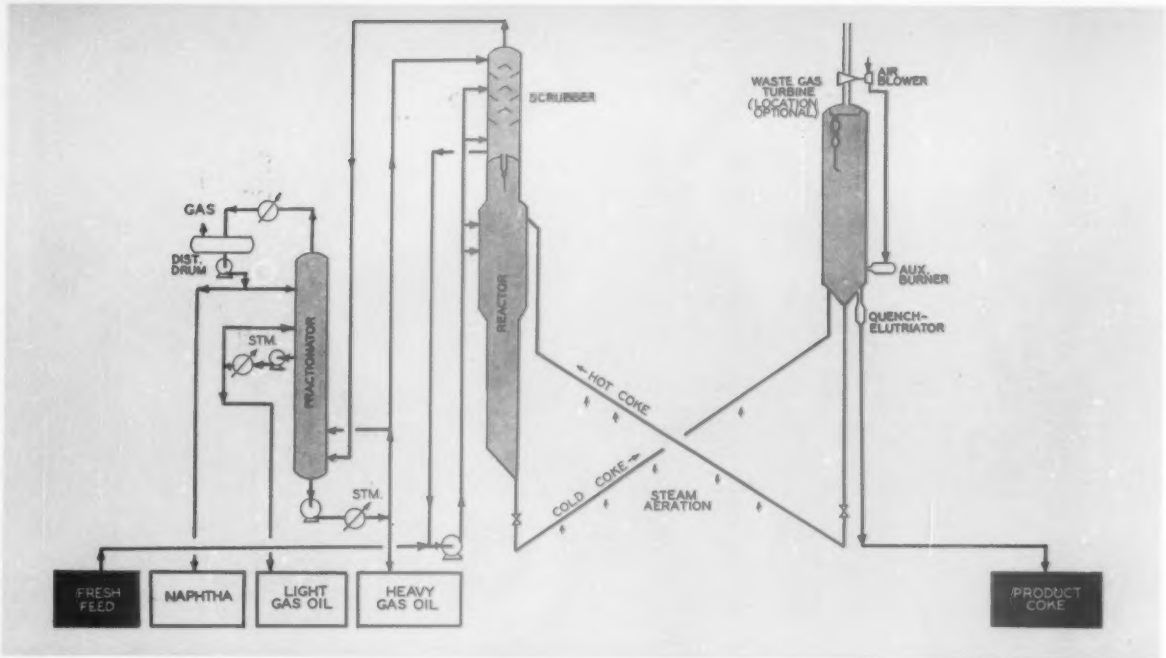
Asphalt solution from the bottom of the decarbonizing tower is heated in a furnace, following which solvent vapors are separated in a pressure flash drum. Final stripping is carried out at low pressure. The asphalt may be cut back for bunker fuel, or blended for marketable asphalt.

Operating conditions. Normally, the top temperature ranges between 160° and 220° F.; pressures from 450 to 600 psig. Solvent ratio and temperature gradient are determined by selectivity requirements. Composition of the solvent is adjusted to provide the necessary solubility.

Commercial data. At the time, 12 propane decarbonizing units are in operation. Information on the process may be obtained from M. W. Kellogg Co., New York.

TYPICAL YIELDS AND PRODUCT PROPERTIES

	1	2	3	4	5
Reduced Crude:					
Vol. % crude	11.1	19.8	22.2	32.3	29.2
Gravity, °API	11.3	13.0	5.3	10.1	12.0
Conradson carbon, Wt. %	15.0	13.3	21.5	16.0	12.1
S.s.U. at 210° F.	2193	812	....	....	526
S.F.s. at 210° F.	....	....	772	162	....
SiO_2-Free ash, p.p.m.	489	149	350	237	936
Metals, p.p.m.:					
Vanadium	23.1	27.6	84.1	61.6	27.6
Nickel	14.2	11.9	27.6	19.9	16.0
Iron	18.2	56.6	13.2	6.7	13.2
Copper	....	....	3.7	0.8	1.6
Decarbonized Oil:					
Vol. % charge	62.9	69.0	35.0	47.0	66.0
Gravity, °API	19.0	20.5	19.3	20.3	19.6
Conradson carbon, Wt., %	4.2	2.6	4.3	2.6	2.2
S.s.U. at 210° F.	294	163	193	....	113
SiO_2-Free ash, p.p.m.	9.2	8.9	8.8	7.6	6.2
Metals, p.p.m.:					
Vanadium	1.23	0.36	1.88	0.73	1.34
Nickel	1.10	0.56	0.92	0.38	0.99
Iron	0.49	0.90	0.96	1.70	0.66
Copper	....	....	0.03	0.04	0.15
Asphalt:					
Vol. % charge	37.1	31.0	65.0	53.0	34.0
Specific gravity	1.076	1.086	1.087	1.059	1.083
R & B Soft, penetration, °F.	188	196	142	132	171
Per cent of metals in reduced crude rejected to asphalt fraction	97.1	98.8	99.1	98.6	96.6



Fluid coking

FLUID COKING is a flexible, continuous process for upgrading a wide range of low-value residual stocks to gas oil, gasoline, and byproduct gas and coke. Whole crudes, atmospheric residue, heavy vacuum residue, or asphalt may be charged. In fact, almost any feed stock that can be pumped can be used.

Description. The equipment used in fluid coking is similar to that used in fluid catalytic cracking except that it operates on coarser noncatalytic solids. Small particles of coke, formed during processing, circulate in a fluidized state between the reactor and the burner and act as a heat-transfer medium.

Heat balance is accomplished by circulating coke between the reactor and the burner, where a portion of the gross coke made is burned with blower air to supply preheat and heat of reaction. Net coke is withdrawn as a product through an elutriator which returns fines to the burner.

Distillate products and gas leave the reactor through cyclones and enter a tower atop the reactor where any fine-coke carryover is scrubbed from the reactor vapor. High-boiling distillate is recycled to the reactor and coked to extinction.

New model. The reengineered Model II design (shown in the flow diagram) retains all the process flexibility of present units. Investment and operating costs, however, are substantially lower than that of the original model.

The change in process flow facilitates operation at widely varying recycle cut points. Where coker gas oil is used as feed to a catalytic cracker, and the cat cracker has excess carbon-burning capacity, it would be easy to maximize coker gas oil. Alternatively, a coker gas oil of higher quality can easily be produced by lowering the cut point if the catalytic plant is limited by feed rate or carbon-burning capacity.

Yield data. Yields from fluid coking vary widely with the characteristics of the feed stock and the type of operation. Final boiling point of the heaviest liquid product can be changed by as much as 200° F. by adjusting operating conditions. Propane and butane fractions normally contain about 60 to 75% unsaturates. For a given feed stock, the process makes less coke and more liquid products than other coking methods.

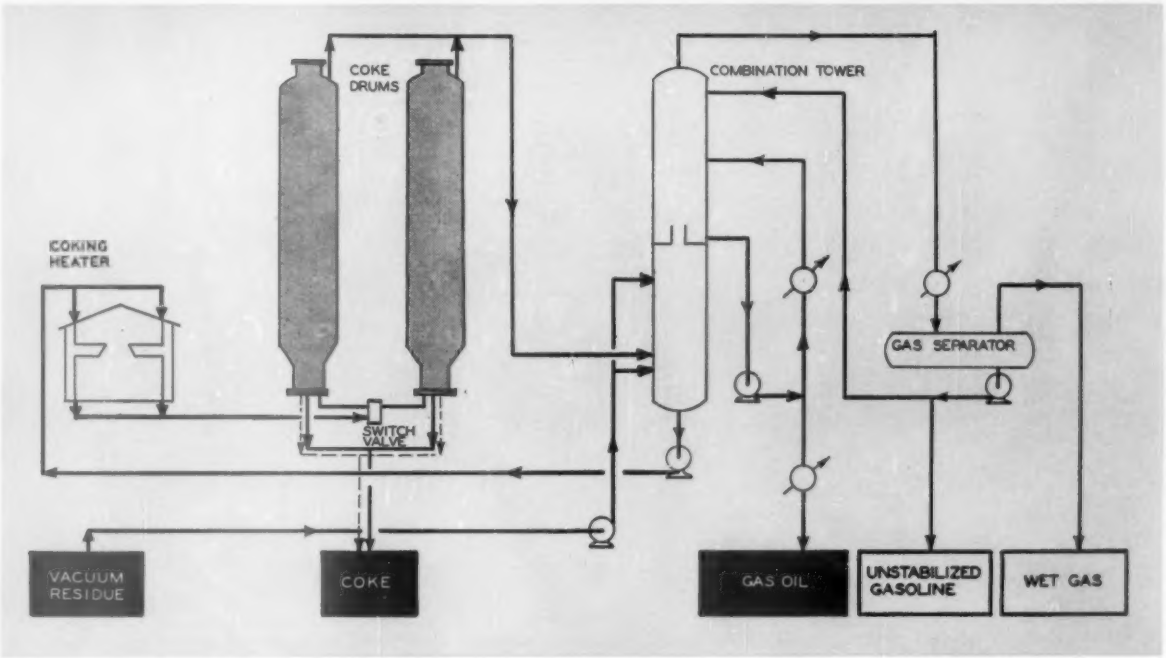
Debutanized coker naphtha has a clear octane number (Research) of about 75 to 85. Gas oils produced are used as charge to thermal and catalyst cracking units, and the butane stream is used as part of the feed to alkylation units. Fluid coke is used in electrodes for aluminum manufacturing and other metallurgical and specialty uses. However, the greatest current use is for boiler fuel.

That fluid coking is a truly continuous process is shown by the performance record. Several units have achieved runs of 10 months or more without interruption or maintenance work. A continuous run of 19 months was scored by one unit.

Commercial data. Developed in the early 1950's, nine units with a capacity of more than 100,000 bbl. per stream day have been built or are under construction. They are listed in the table below. Fluid coking was developed and is licensed by Esso Research & Engineering Co., New York.

COMMERCIAL FLUID COKING UNITS

Company	Location	Capacity b.p.s.d.	Initial operation
Humble	Billings, Mont.	3,800	1954
Humble	Baltimore	Shut down	1955
Canadian Petrofina, Ltd.	Montreal	3,800	1956
Aurora Gasoline Co.	Detroit	4,000	1956
Tidewater Oil Co.	Avon, Calif.	42,000	1956
Tidewater Oil Co.	Delaware City, Del.	42,000	1957
Signal Oil & Gas Co.	Bakersfield, Calif.	4,000	1957
Pontiac Eastern Corp.	Hattiesburg, Miss.	4,800	1957
Petroleos Mexicanos	Tampico	10,000	1962



Delayed coking (Lummus)

DELAYED COKING (Lummus) is an important refining step in the economics of processing heavy asphaltic crudes. The demand for distillate fuels continues to increase at a greater rate than that for residual fuels. It is estimated that within the next 10 years the demand for distillate fuels will increase 25%, while the demand for residual fuels will remain substantially the same.

This situation, plus the fact that the average refinery charge will have a higher proportion of heavy-crude stocks, demands that more distillate stock (per barrel of crude) be produced in the future. Of additional importance is the need for electrode coke for use by the burgeoning aluminum industry. This requires approximately ¾ lb. of coke for each 1 lb. of aluminum produced.

New units. Industry's appreciation of the trend is attested by the delayed-coking units now being installed, and others being projected, in the general area of the Gulf Coast and the eastern seaboard. Heretofore this area has been able to satisfactorily dispose of all its heavy fuel oils. It has been estimated[1] that within the next 10 years additional coking capacity equivalent to 75 to 80% of the present coke-producing facilities will have to be built.

Natural deposits (for example, gibsonite, shale oil, and sand oil) can be converted to usable light fuels by delayed coking plus catalytic hydrogenation. Furthermore, coke produced from these sources will have very low sulfur content. This makes it particularly well suited for electrode use, and perhaps gives added attractiveness to the exploitation of these sources.

Yields. The tables of yield and product specifications and the delayed-coker flow diagram illustrate an operation based on processing a heavy Tia Juana vacuum residue. A significant feature of this operation is the 41.6 vol. % yield of excellent gas oil for catalytic cracking, and 35.6 wt. % yields of coke obtained from a residue with a 5% boiling point of 1,015° F.

Lummus has developed a technique for successfully processing heavier vacuum bottoms than have heretofore been charged to a coker. Charge stocks, such as gilsonite and coal-tar pitch that would yield over 50 wt. % coke, can also be processed.

Information on delayed coking may be obtained from Lummus Co., New York.

Reference

1. "New Developments and Techniques in Delayed Coking," by Valentine Mekler and Maurice E. Brooks. Presented to twenty-fourth mid-year meeting of the API Division of Refining, New York, May 28, 1959.

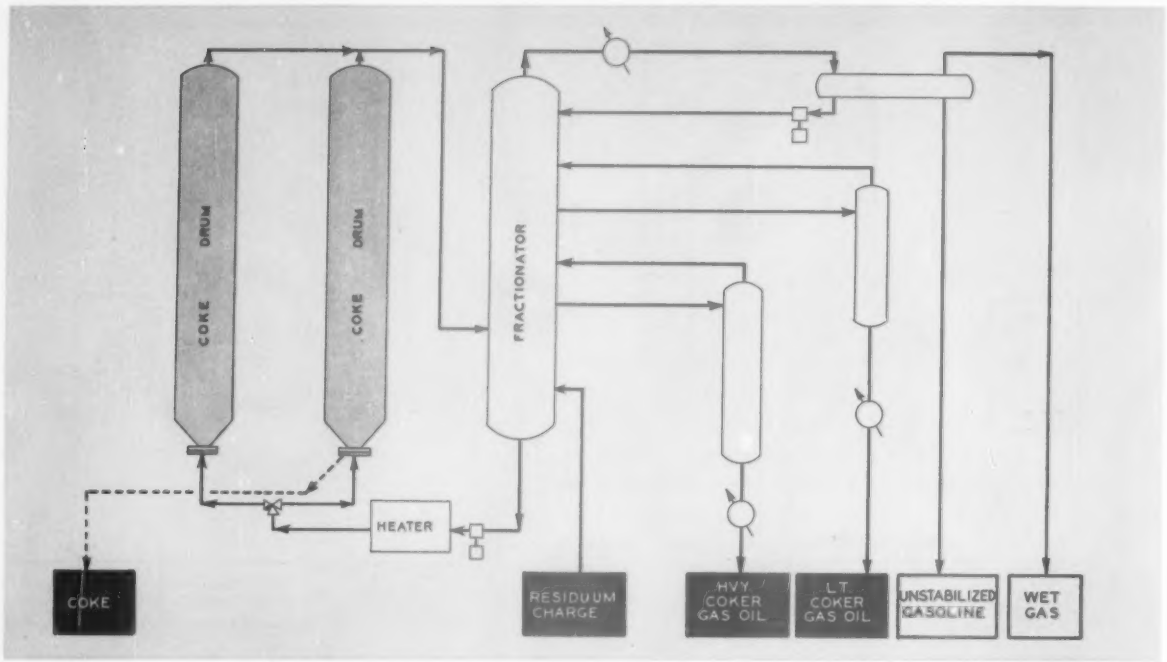
PRODUCT YIELD SUMMARY

	B.p.s.d.	API	Lb./hr.	Wt. %	Vol. %
Charge	9,660	7.7	143,120	100.0	100.0
Product:					
Wet gas			11,310	7.9	
Unstabilized gasoline	2,678	60.5	28,770	20.1	27.7
Gas oil	4,016		52.090	36.4	41.6
Coke			50,950	35.6	

CHARGE AND PRODUCT SPECIFICATIONS

Charge Stock		Wet gas (mol. wt. = 30.7)	mole %
Gravity °API	7.7	C_2, lighter	69.2
S.F.s. at 210° F.	1,200	C_3's	16.2
Conradson carb. wt. %	20.9	C_4's	7.6
Dist. vac. corrected to 760 mm:		C_5 +	6.0
I.b.p., ° F.	860		
5%	1,015		

Debutanized Gasoline		Gas Oil	
Gravity, °API	56.8	Gravity, °API	27.5
R.v.p., psi.	4.0	Conradson carb. wt. %	0.10
Octane, clear	64.0	Sulfur, wt. %	2.2
ASTM dist., °F.:		Dist. vac. corr'd to 760 mm.:	
95%	375	I.b.p., °F.	410
E.p.	400	E.p.	950



Delayed coking (Kellogg)

THE PROCESS converts heavy oils into coke and more valuable light-hydrocarbon products. The charge can be reduced crudes either from atmospheric or vacuum flashing, fuel oils either from visbreaking or distillate thermal cracking, and heavy catalytic cycle oils.

The process is continuous. A transfer-line manifold using a specially designed switch valve makes it possible to feed any drum without interrupting furnace operation. Other equipment can be added to permit operation as a viscosity breaker of reduced crudes when fuel oil is in demand.

Quality. Coker gasoline is a potential charge either to catalytic reforming or to gasoline blending. The coker gas oil is a clean (low Conradson Carbon) material suitable as charge stock for catalytic cracking or fuel-oil blending. The quality of coke produced depends on the charge stock; coke of low sulfur and metal content has a premium value.

Description. Feed is charged to the base of the bubble-tower fractionator. Tower bottoms, consisting of fresh feed plus recycle, are rapidly heated in a furnace to 900°-950° F. and discharged into insulated coke drums operating at 10 to 70 psig. After a certain residence time and temperature, coke is formed. Drum-top temperature range is 800°-850° F.

Vapors leaving the coke drums are a wide-boiling mixture of gas, gasoline, gas oil, and heavy gas-oil recycle fractions, the result of cracking both in the furnace coil and in the drum. These vapors enter the lower section of the fractionator at which point the quantity of recycle condensed is controlled by the gas-oil reflux to this section. The net vapors are separated into gas, gasoline, and gas oil.

To increase thermal efficiency of the unit, it is a general practice to split the gas oil into a light and heavy cut. Intermediate reflux system from the heavy gas-oil drawoff provides charge preheat, steam generation, or reboiler heat to gas recovery.

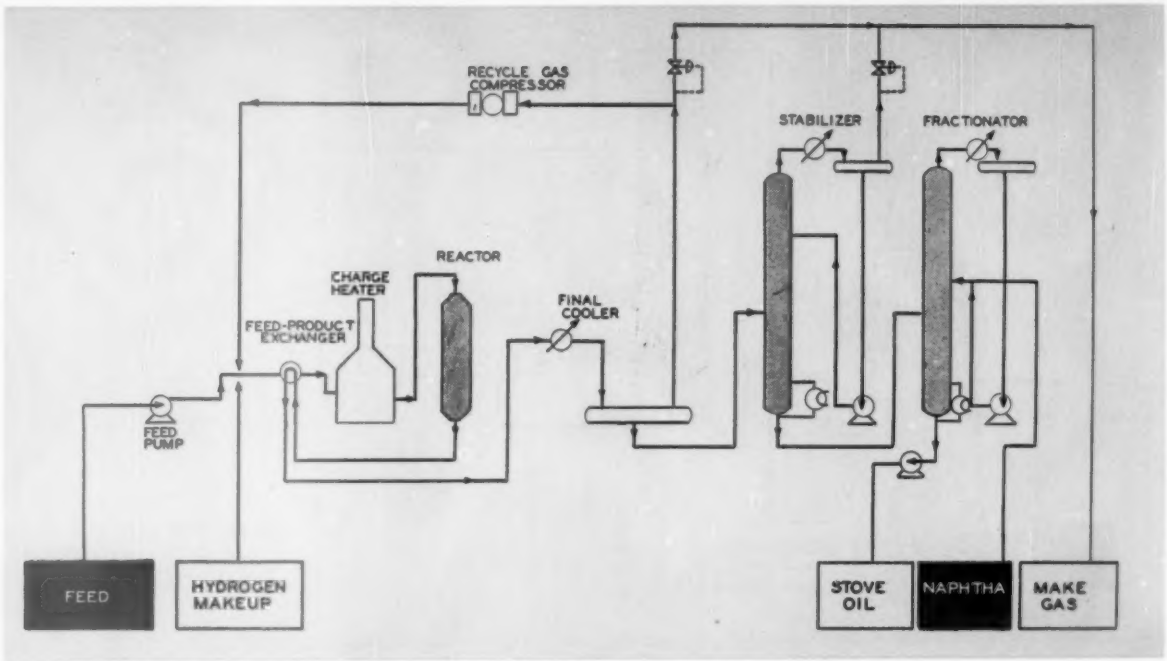
The number of coke drums required is determined by the feed rate and carbon-forming characteristics of the charge stock. At any given time, half of the drums are coking and the other half decoking. The usual cycle per drum is 48 hours—24 hours coking and 24 hours decoking.

Coke accumulates in a drum to a controlled level, at which time the furnace effluent is switched to the adjacent heated drum.

Information on process may be obtained from M. W. Kellogg Co., New York.

TYPICAL YIELDS

	Atmospheric residuum	Vacuum residuum
Reduced crude charge:		
Wt. %	100.0	100.0
Gravity °API	15.7	10.0
Conradson carbon, %	10.8	21.6
Stabilized gasoline:		
Vol. %	20.4	23.8
Gravity °API	58.4	57.0
Reid vapor pressure	8.0	6.1
C.F.R.-R. octane number, clear	64.7	61.7
Gas oil:		
Vol. %	61.1	46.1
Gravity °API	27.5	27.0
Conradson carbon, %	0.15	0.15
Dry gas, wt. %	5.8	8.0
Coke:		
Wt. %	22.3	33.4
V.C.M.	10.1	11.7
Ash, %	0.1	0.12



Unifining

UNIFINING is a versatile catalytic hydrogenation process for removing sulfur, nitrogen, oxygen, and other contaminants from hydrocarbon feed stocks.

Objectives. The process (1) removes sulfur and nitrogen, (2) removes catalytic coke-forming materials, (3) removes catalytic reforming poisons, (4) improves gasoline yield and catalytic cracking susceptibility, (5) improves lead susceptibility and storage stability, (6) improves odor, color, and burning properties of all treated streams.

Process. The diagram shows a typical equipment arrangement for a unit using recycle gas. However, there are many applications where once-through hydrogen flow is adequate.

Feed is combined with reactor products and heated to the required reactor-inlet temperatures. On passing through the reactor, the desired catalytic reactions are accomplished. These may occur in either vapor-phase or mixed-phase conditions, depending on the specific application.

Reactor products, after heat exchange, are cooled and flow to a high-pressure separator. Hydrogen-rich gas is usually recycled to the reactor. Any excess over process requirements is vented to fuel. The high-pressure separator liquid flows to a stabilizer for removal of dissolved light gases. The stabilized product may be used directly or further fractionated.

Operating conditions. Unifining is adaptable to many different feed stocks and desired product properties. Thus, operating conditions may be established over a wide range. Those most commonly used are:

Pressure, 300-1,000 psig.

Temperature, 550°-800° F.

Liquid hourly space velocity, 1.0-6.0 vol. oil per hour per vol. cat.

Hydrogen to oil ratio, 300-5,000 std. cu. ft. per bbl.

These wide process variations, plus plant-size factor, cause wide variation in operating and capital costs.

Operating and capital costs. Typical direct operating costs and capital investments for the most common applications are:

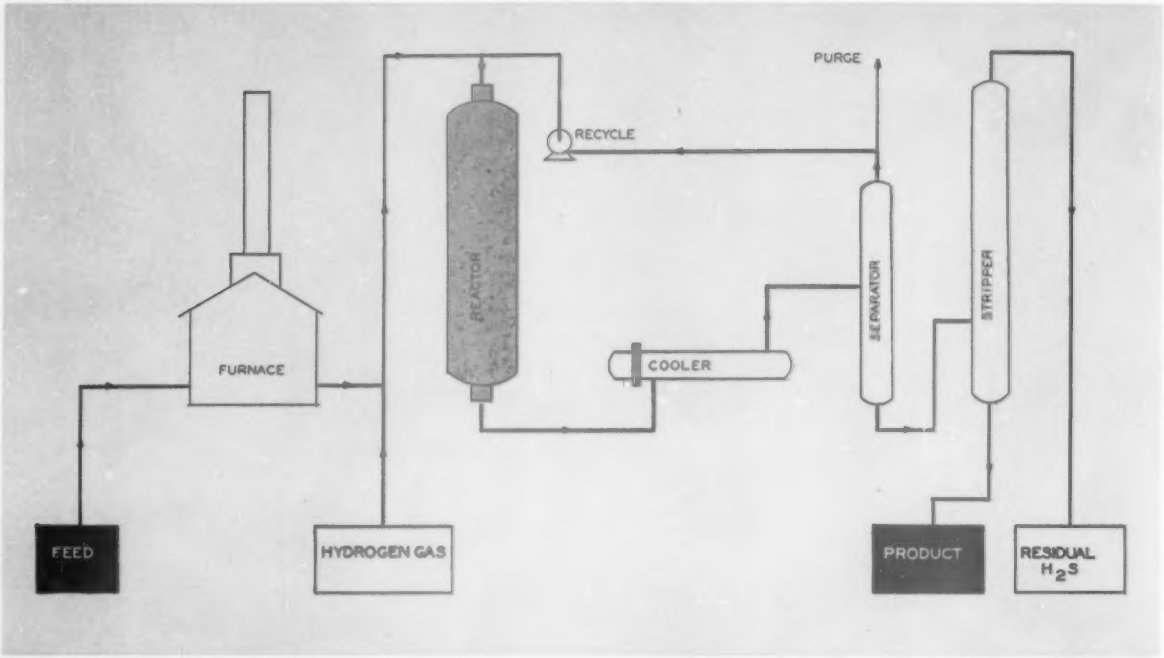
	Cents per barrel
Operating labor and supplies	0.8 - 1.1
Utilities	0.8 - 4.1
Maintenance	1.2 - 2.8
Catalyst	0.6 - 1.2
	3.4 - 9.2

Capital investment (10,000 b.p.s.d.) $75-$175 per daily barrel.

Commercial Data. Two examples of commercial data from current operations are given below:

	Calif. coker distillate products			Middle East SR diesel oil	
	Charge	Rerun O.H.	Rerun bottoms	Charge	Product
Gravity, °API	47.8	55.0	38.6	37.0	39.3
I.b.p.	190	152	390	401	390
10%	230	212	390	441	430
50%	300	270	415	501	493
90%	400	340	432	587	581
Max.	450	380	490	627	622
Sulfur, total wt. %	1.90	0.005	0.01	1.30	0.05
Nitrogen, basic, p.p.m.	225	0.2	1.0	...	...
Bromine No.	20	Nil	Nil	...	...
Doctor test	Sour	Sweet	Sweet	Sour	Sweet
Liquid yield, vol. % of charge		101		100+	

Commercial installations. Over 60 commercial units have been licensed for operation. These units represent applications of Unifining to straightrun, thermal, catalytic and coker naphthas; straightrun kerosine and jet fuels, diesels, and burner oils; vacuum, visbreaker, and coker distillates and gas oils; catalytic cycle stocks; aromatic distillates; and lube oils. A Unifining license may be obtained from either Universal Oil Products Co. or Union Oil Co. of California.



Hydrofining

HYDROFINING is a versatile hydrogenation process used for sulfur removal and the general upgrading of products ranging from gasolines to waxes.

Applications. Essentially 100% of the oil fed to a Hydrofiner is recovered as finished product.

Applied to naphthas, it reduces the sulfur content and removes gummy deposits which tend to foul engines. For kerosine it desulfurizes, improves color and odor, and reduces wick char. For diesel fuel stocks, Hydrofining greatly reduces sulfur, improves diesel index and color, and holds carbon residue at a low level.

It effectively stabilizes and improves heating oils. And it upgrades cracked gas oils to heating oils as well. Catalytic cracking feed stocks which have been Hydrofined yield more naphtha and heating oil, and less gas and carbon than do untreated stocks. It improves the odor, color, and stability of refined waxes.

Process flow. Operating conditions are not severe, normally ranging from 550° to 800° F. and from 50 to 800 psi.

As shown in the diagram, heated oil from the furnace passes to the fixed-bed reactor together with the hydrogen gas. After leaving the reactor, the product is cooled and run to a separator where hydrogen-rich gas is separated. Amount recycled to the reactor depends upon the specific requirements of the finishing operation.

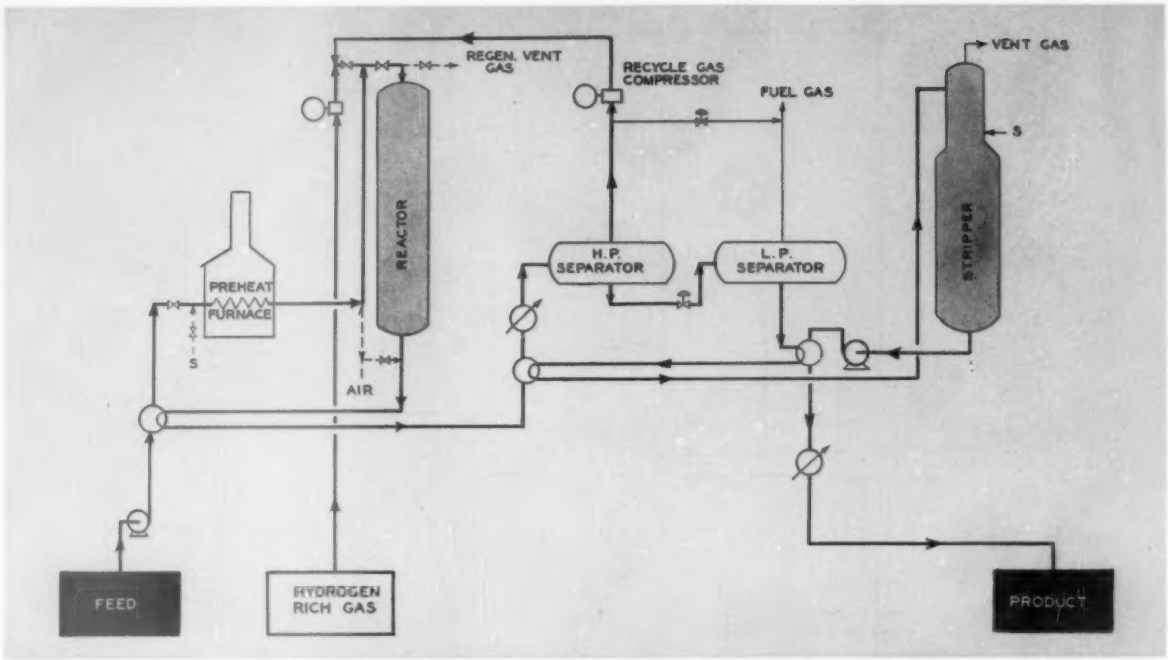
Commercial data. As shown in the table, 75 Hydrofiners are in operation or being constructed. Their combined capacity is about 673,000 bbl. per stream day. Slightly more than one-third of the capacity is in United States refineries. About 255,000 bbl. of the capacity is for removal of sulfur from feed stocks for catalytic reforming units. Hydrofining was developed and is licensed by Esso Research & Engineering Co.

HYDROFINING UNITS IN OPERATION AND UNDER CONSTRUCTION

Principal feed stock	No. of units	Capacity, b.p.s.d.
Catalytic reformer feeds	26	254,430
Other naphthas	5	66,640
Solvents	6	18,270
Coal tar aromatics	1	1,300
Jet fuel, kerosine, diesel fuels, etc.	26	244,730
Heavy gas oils	2	53,800
Lubricating oils	6	29,700
Wax	3	4,100
Total	75	672,970

HYDROFINING DIESEL FUELS

	West Texas (308°-641° F.)			Elk Basin (478°-634° F.)		83% Virgin Arabian 17% catalytic stock (495°-682° F.)	
	Feed	Products		Feed	Product	Feed	Product
Sulfur	0.92	0.15	0.50	1.3	0.25	1.6	0.35
Copper number	92	<1	<1	34	<1	.....	<1
Gravity, °API	37.9	38.4	38.4	31.4	33.5	30	32
Aniline point	143	150	145	154	154	151	154
Diesel index	54	58	56	48	52	45	50
Cetane number	.....	53-55	53-55	46	46	51	52
Bromine	.....	.....	.....	.....	.....	10	1
Color, TR	17	17	18	14	22	.....	.....
Carbon residue, 10%	0.03	.....	0.04	0.02	0.02	0.06	0.02



Ultrafining

ULTRAFINING is a catalytic hydrogenation process used primarily for desulfurization, denitrogenation, and olefin saturation.

Process flow. The flow diagram shows typical processing steps for treating cycle-oil stocks. The feed is preheated, mixed with hydrogen-rich makeup and cycle gas, and charged to the reactor. Reactor effluent is cooled, the liquid product separated and then stripped to remove H_2S. The cobalt-molybdenum-on alumina catalyst is regenerated at infrequent intervals with steam diluted air.

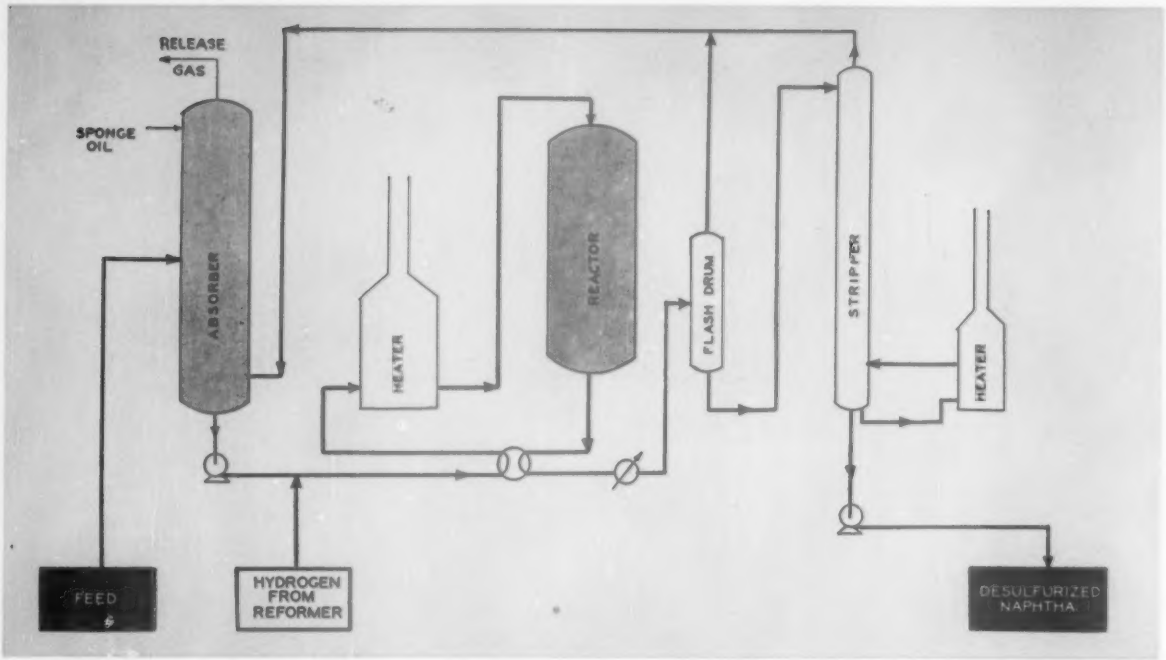
Operating conditions. Usual process conditions include temperatures in the 600°-800° F. range, pressures from 200 to 1,500 psig., space velocities from 1-20 vol./hr./vol., and hydrogen addition rates from 500 to 4,000 std. cu. ft. per barrel. Depending upon feed stock, the reactions may be carried out in either the vapor or mixed phase. Typical economic elements for a 8,500-bbl. plant are given in Table 2.

Commercial data. There are 23 Ultrafiner units in operation, having a total capacity of about 250,000 bbl. daily. American Oil Co. is the licensor.

TABLE 1—TYPICAL ULTRAFINING APPLICATIONS

	Pretreat Reformer Feed[1]		Make No. 1 Fuel Oil[2]		Upgrade Diesel Fuel[3]	
	Charge	Product	Charge	Product	Charge	Product
Gravity, °API	56	57	41	42	31	33
ASTM Distillation, °F.						
I.b.p.	175	170	346	349	368	376
10%	209	207	386	389	426	426
50%	252	251	450	446	494	489
90%	323	325	518	515	560	565
Maximum	375	380	552	550	626	631
Olefins, vol. %	15	1	.....	.....	.....	.....
Bromine No.	29	0.5	.....	.....	.....	.....
Sulfur, wt. %	0.32	0.0006	0.60	0.06	1.10	0.09
Nitrogen, wt. %	0.0031	0.0002	.....	.....	.....	.....
Yield, vol. % charge	.....	100	.....	98.0	.....	95.5
400° F.-e.p. gasoline	.....	.....	.....	2.8	.....	6.1
Sediment[4]	.....	.....	.....	.....	1.9	0.8
Color, Saybolt	.....	.....	+25	+27	.....	.....
Color, stability, Saybolt	.....	.....	Poor	+13	.....	.....
Air-jet gum, mg per 100 ml.	.....	.....	.....	.....	83	20
Floc gum, mg per 100 ml.	.....	.....	.....	.....	14.4	5.3
Worrall burner:						
Side deposits	.....	.....	3	0.6	.....	.....
Bottom deposits	.....	.....	13	11	.....	.....
Odor	.....	.....	Poor	Good	.....	.....
Doctor	.....	.....	Sour	Sweet	.....	.....
Cetane No.	.....	.....	.....	.....	36.7	40.8

1. Remove sulfur, nitrogen, saturate olefins from 60% virgin and 40% coker naphtha.
2. Remove sulfur, reduce deposits, improve odor and color stability of W. Texas virgin heater oil.
3. Reduce sulfur, improve stability and cetane number of feed (84% cat. cycle oil, 16% coker gas oil).
4. Accelerated aging, 20 hours at 200° F.



Hydrodesulfurization (Sinclair)

SINCLAIR REFINING CO's. hydrodesulfurization process, developed by Sinclair Research Laboratories, Inc., uses a cobalt molybdenum on alumina catalyst produced by Nalco Chemical Co.'s catalytic division.

The process is applicable to catalytic reformer feedstock preparation, heating-oil stabilization, and related uses. Nalco's unique method of manufacture produces a rugged ⅛-in. extrudate, with excellent desulfurization activity and high surface-area, low attrition-loss properties.

Catalyst regeneration. The catalyst normally operates for long periods without regeneration. When necessary, regeneration is accomplished in 24-72 hours, using steam-diluted air to burn carbonaceous deposits. Activity and selectivity of the catalyst are returned to essentially virgin quality.

Operating conditions. Important operating variables are temperature, pressure, space velocity, and hydrogen recycle. Temperatures range from 580° to 780° F. During the operating cycle, temperature is usually raised to compensate for decline in catalyst activity. Pressures range from 200 to 800 psig.

Space velocity ranges from 2, for high-sulfur fluid-cycle oil, to 10 for straightrun napthas. Hydrogen recycle ranges from 500 std. cu. ft. per bbl. of feed for straightrun naphthas, to as high as 5 M.s.c.f. per barrel for cycle oils.

Operation. The flow diagram shows the reformer-feed desulfurization unit at Sinclair's Houston refinery. This unit processes 24,000 bbl. per day of straightrun naphtha, reducing sulfur from about 600 to 30 p.p.m. Nitrogen content is reduced from about 10 to less than 1 p.p.m. Arsenic content is lowered to less than 4 parts per billion (p.p.b.) from the 10 p.p.b. contained in the charge. Yields from typical applications are given in the table.

This unit operated for more than 16 months on the first catalyst charge without regeneration. Desulfurization was still better than 90%, although operating temperature had increased from 650° to 735° F. Catalyst life at regeneration was 235 bbl. per lb. After regeneration the catalyst was charged to a distillate treating unit where it has been in service for more than 3 years.

Sinclair and others have on stream, or in the planning stage, total desulfurizing capacity of 123,000 bbl. per stream day. Feed stocks range from lube oils to fluid cycle oil, heating oil, and straightrun naphtha.

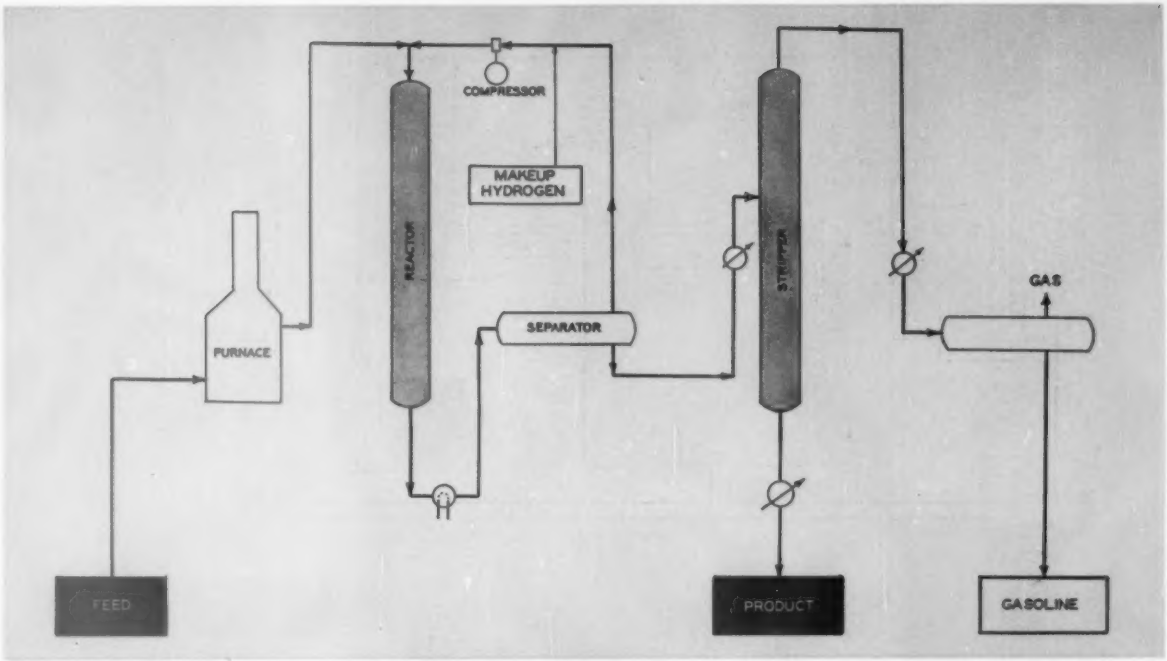
TYPICAL HYDRODESULFURIZATION APPLICATIONS

	Straightrun naphtha	Virgin heating oil	Fluid-cycle oil
Processing conditions:			
Temperature, °F.	700	700	680
Pressure, psig.	250	500	500
Wt. hourly space velocity	6	4	2
Hydrogen recycle, std. cu. ft. per bbl.	800	1,000	3,500
Hydrogen consumption, std. cu. ft. per bbl.	10	110	210

	Charge	Product	Charge	Product	Charge	Product
Inspection tests:						
Gravity, °API	55.0	55.3	37.4	38.8	25.9	29.2
Sulfur, wt. %	0.060	0.003	0.80	0.05	1.80	0.08
Bromine no.	1.2	0.2	7.0	1.0	24.0	8.0
Nitrogen, p.p.m.	1	0	15	7	30	15
Arsenic, p.p.b.	10	4	..	..	..	..

TYPICAL OPERATING EXPENSES OF A 10,000 BBL.-PER-DAY GULF COAST PLANT TREATING STRAIGHTRUN NAPHTHA

	Cents/bbl.
Labor (including benefits)	2.2
Maintenance (labor and materials)	2.6
Utilities	4.2
Catalyst	0.3
Hydrogen	negligible
Taxes and insurance	1.3
Total (excluding overhead)	10.6



Trickle hydrodesulfurization

THE SHELL TRICKLE hydrodesulfurization process is featured by its relatively low hydrogen recycle rate, and treatment of the oil largely in the liquid phase.

Objectives are the desulfurization of petroleum distillates, removal of nitrogen, hydrogenation of condensed polycyclic aromatics, and removal of heavy metallic contaminants from catalytic cracking feed stocks. The charge can range from light gasoline to heavy vacuum gas oils and even deasphalted oils.

Process flow. The hot feed, together with hydrogen, is charged to an adiabatic reactor where it trickles downward through fixed catalyst beds. After heat exchange, the reactor product is flashed. The flash vapor, consisting mostly of hydrogen, is recycled to the reactor. The flash liquid is charged to a stripper which removes dissolved gases and light ends (gasoline) and gives the final product.

Operating conditions depend upon the character of the feed stock and the results desired. Pressure may range from a few hundred to as high as 1,500 psi. Temperature is normally 600° to 800° F. The hydrogen recycle rate is normally under 1,200 std. cu. ft. per bbl. of charge.

Results. Trickle hydrogenation of catalytic cracking feed stocks improves the cracking qualities of the stock. At constant conversion, coke formation is reduced 40 to 60% and the gasoline yield increased. At higher constant coke production, gasoline yield from the treated stock is 25 to 40% higher.

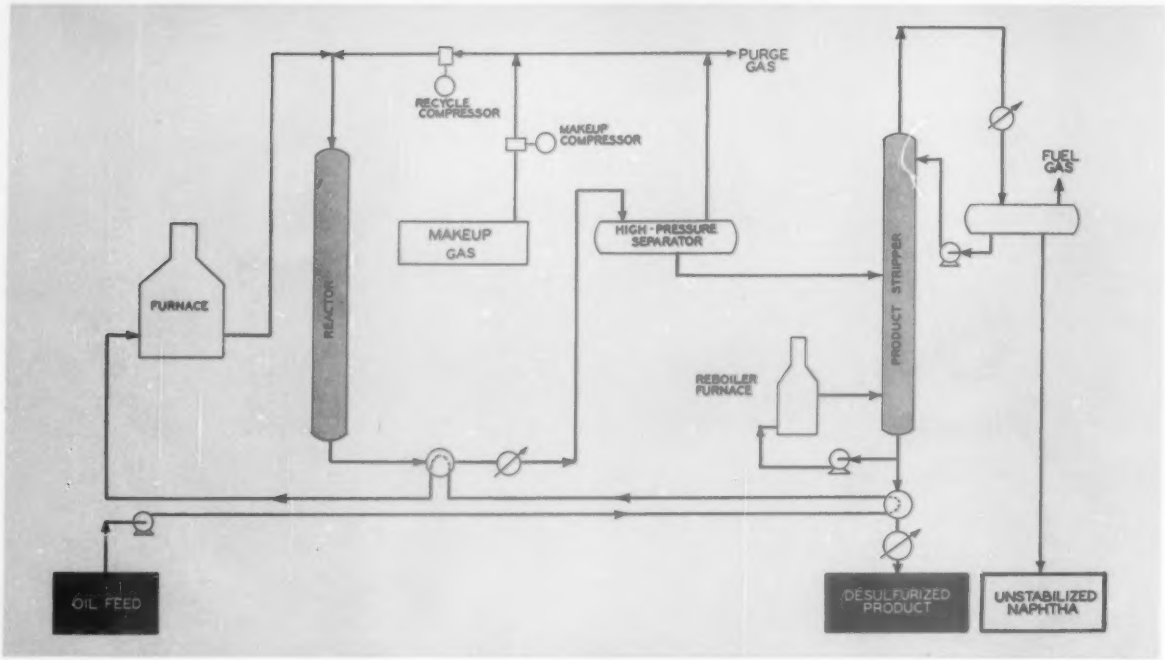
Volumetric yields are over 100%, API gravity and diesel index are increased, and sulfur is almost completely removed. Also, the product has better color stability.

Economic data. The process's relatively low hydrogen recycle rate effects savings of about 20% in capital costs and 1 to 2 cents per barrel in operating cost, as compared with vapor-phase operations. Capital costs range from $50 to $200 per daily barrel throughput. Direct operating costs are normally less than 10 cents per barrel of charge.

The 24 Trickle units in operation have a total capacity of more than 260,000 bbl. daily. The process was developed by Shell Development Co.

TABLE 1—EFFECT OF HYDROGENATING CATALYTIC CRACKING FEED STOCKS

	West Texas vacuum gas oil		Catalytic cycle stock	
	Untreated	Treated	Untreated	Treated
Hydrogenation				
Pressure, psig.	...	1,500	...	750
Hydrogen consumed, s.c.f. per bbl.	...	530	...	500
Properties of catalytic cracking feed:				
Gravity, °API	25.5	29.9	21.5	25.7
Sulfur, wt. %	1.68	0.05	1.52	0.09
Monoaromatics, wt. %	23	25	12	20
Polyaromatics, wt. %	21	5	39	24
Catalytic cracking yields, wt. % at constant conversion:				
Conversion	56	56	50	50
Coke	5.8	2.0	12.6	7.1
Gasoline (C_5 —430° F.)	33.1	37.5	23.1	28.1
At constant coke:				
Conversion	49.5	63.4	42.5	56.5
Coke	4.0	4.0	10.0	10.0
Gasoline (C_5 —430° F.)	31.8	39.0	21.0	29.3



Hydrodesulfurization (Kellogg)

A SERIES of hydrodesulfurization and mild hydrogenation units developed by M. W. Kellogg Co. efficiently treat high-sulfur, high-contaminant distillate fractions, both straightrun and cracked, and ranging from naphthas through vacuum gas oils.

Objectives. The process, which uses a cobalt molybdate catalyst, removes sulfur, nitrogen, oxygen, and metallic compounds from raw naphthas and distillates. When cracked or degraded feed stocks are processed, unsaturated components are eliminated, thus restoring color and stability to the finished product.

Process flow. As shown in the flow diagram, incoming oil feed is heated by exchange with product-stripper bottoms and total reactor effluent. In the furnace it is heated to a temperature slightly higher than required for reaction.

Hydrogen-rich feed gas, after compression, is combined with the recycle gas stream, and, after further compression, the combined stream is heated by exchange against the total reactor effluent. It is then mixed with the oil feed at the reactor inlet.

A variety of proved reactor designs insure optimum treating (in blocked operation) of widely differing feed stocks in the same process unit. Provision may also be made to control the highly exothermic heat of reaction associated with the treating of certain feed stocks.

Reactor effluent heats incoming streams and then is flashed in the high-pressure separator. Flash vapor, after elimination of a small purge stream, is used as recycle while the liquid is fed to the product stripper. Gases and light ends are overhead products from the stripper. Stabilized bottoms may be processed further, or sent directly to finished-product storage.

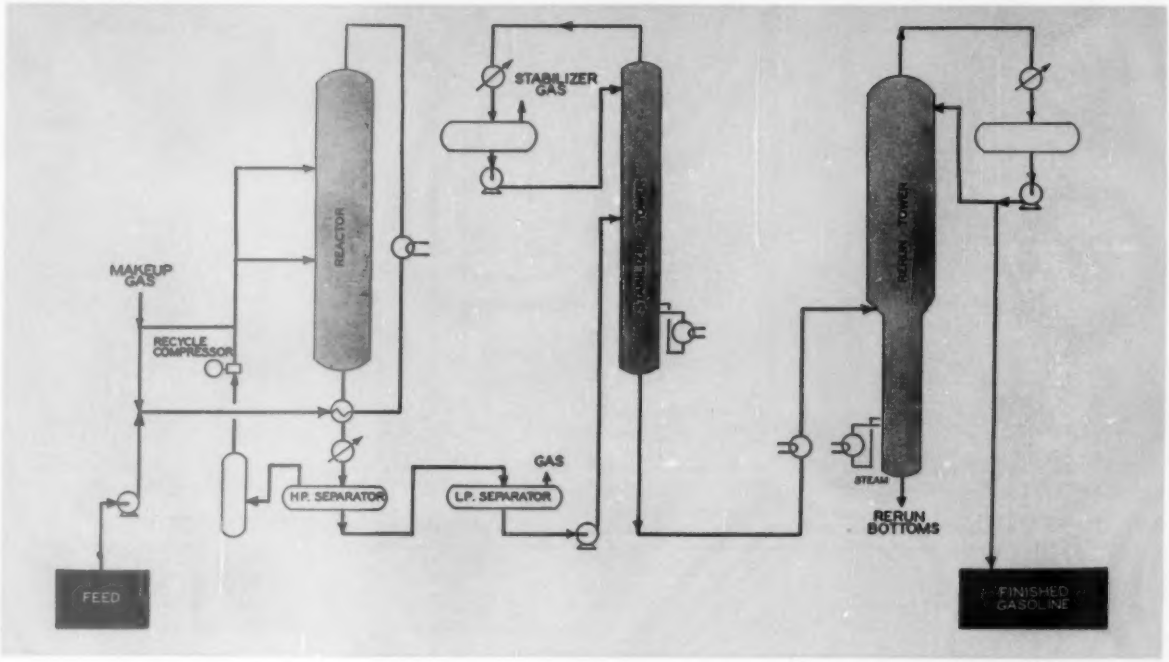
Operating cycles of units range from several months, when treating heavy, highly contaminated stocks, to periods in excess of 1 year when treating straightrun naphthas. Facilities are provided for in-place regeneration of catalyst, using a combination of steam and air. In some cases an auxiliary regeneration heater is included. In others the normal process heater is used.

RESULTS OF HYDRODESULFURIZING—SOUR MIDDLE DISTILLATES

	Straightrun gas oil		Lt. cat. cycle stock	
	Feed	Prod.	Feed	Prod.
Gravity, °API	39.3	40.0	26.6	28.0
ASTM distillation, °F.				
I.b.p.	340	370	420	430
E.p.	600	600	650	650
Sulfur, wt. %	0.70	0.05	0.80	0.10
Wt. % desulfurization	....	93.0	....	87.5
Fuel oil, vol. % on feed	....	96.8	....	98.0
Unstabilized gasoline, vol. % on feed	....	3.7	....	3.0

Operating conditions. Depending upon feed stock characteristics and the degree of improvement desired, reactor temperatures range from 650° to 800° F.; pressures from 350 to 1,000 psig. Recycle-gas rates vary from 400 to 3,000 std. cu. ft. per bbl. of charge.

Commercial data. Kellogg distillate-desulfurization units, both operating and under construction, processing feed stocks ranging from kerosine to heavy gas oil, account for a combined capacity in excess of 180,000 bbl. per stream day. Naphtha desulfurization units, used primarily as catalytic-reformer pretreaters, include an additional 162,000 bbl.



Selective hydrogenation

SELECTIVE HYDROGENATION was developed by British Petroleum Co., Ltd., for improving the gum stability of byproduct gasoline derived from steam-cracking light naphthas.

Gum-forming compounds, such as diolefins, are selectively hydrogenated in a downflow, fixed-bed reactor. Finished gasoline is produced in high yields, has excellent gum stability, and shows no loss in leaded octane number.

Process flow. The three-step operation consists of:

(1) Reaction of the gasoline feed and hydrogen in the reactor,

(2) Stabilization of the hydrogenated gasoline to remove hydrogen and light hydrocarbons, and

(3) Rerunning of the stabilized gasoline to produce the finished product as a distillate.

For blending purposes it may be convenient to produce two distillates, a light and heavy gasoline. Finished products are inhibited with a phenylenediamine antioxidant.

Process conditions are in these ranges: Pressure, 300 to 600 psig.; temperature, up to 350° F.; space velocity, 0.5 to 5.0 volume per volume per hour; gas rate (recycle gas plus makeup), 500 to 1 M.s.c.f. per barrel; and hydrogen absorption, 100-200 std. cu. ft. per bbl. Makeup gas is either catalytic-reformer exit gas or other suitable hydrogen stream.

Yield data. Typical yield and product quality from the first commercial unit are given in the table. The low-cost catalyst has an expected life of more than 6 months. No regeneration equipment was included in commercial units. All major items of equipment are fabricated of carbon steel.

Utility requirements, per 1,000 lb. of daily feed, are:

High-pressure steam (170 psig.), lb. per hour	5,500
Low-pressure steam (40 psig.), lb. per hour	440
Cooling water (77°-113° F.), U. S. gal. per min.	410
Electricity, kw.	70

Commercial data. Three units, ranging in capacity from 2,600 to 8,500 bbl. per stream day, are in operation.

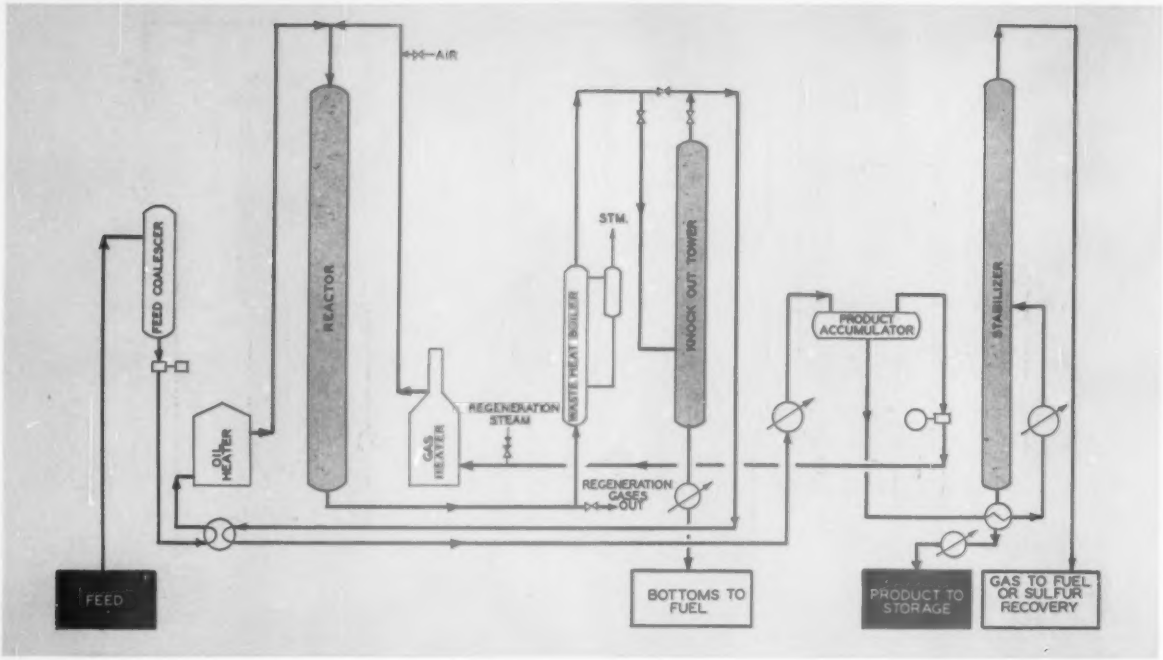
P. T. White, F. W. B. Porter, and A. A. Yeo presented a paper: "Selective Hydrogenation Process for the Refining of Steam Cracker Gasoline," at the Fifth World Petroleum Congress, New York, May 1959, which describes the unit in more detail.

YIELD AND PRODUCT DATA

Yields:	
Finished gasoline wt. % on feed	96
Residue wt. % on feed	3.5
Stabilizer gas wt. % on feed	0.5

Product quality		Feed*	Product*
Gravity at 60° F., °API		50.8	52.5
Distillation:			
I.b.p.	°F.	95	102
10%	°F.	126	131
50%	°F.	187	181
90%	°F.	316	295
F.b.p.	°F.	369	374
Bromine number		67	52
Gum existent	mg. per 100 ml.	149	1
Gum accelerated (120 min.)	mg. per 100 ml.	321	2
ASTM induction period, minutes		175	>720
F-1, clear		92.8	92.4
F-1 + 2.25 ml. TEL per U. S. gal.		95.4	96.5

*Inhibited with phenylenediamine antioxidant.



Autofining

THE AUTOFINING process was developed by British Petroleum Co., Ltd., for catalytically desulfurizing distillate charge stocks, using hydrogen which comes from dehydrogenating part of the feed stock.

Charge stocks ranging from straightrun naphthas to 700° F. e.p. gas oils have been successfully treated. Applied to straightrun naphthas, desulfurization is accompanied by a 2-4-octane number (clear) increase, and a greatly improved lead response. Moderate temperature and pressure conditions are employed.

Process flow. As shown in the flow diagram, separate heaters are used to bring the feed stock and recycle gases up to reactor temperatures. This permits a lower pressure drop to be handled by the recycle compressors, and makes it necessary to use stainless steel only in the recycle-gas circuit.

Reactor products, after passing through a waste-heat boiler, go to a knockout tower. There 1-2% of the heavy ends are removed, when end point or color improvement is desired in producing power gasoline. With a naphtha feed this step is not required.

Operating conditions. Typical operating conditions include: Pressure, 100 to 200 psig.; temperature 750°-800° F.; space velocity, 1-5 vol./vol./hr.; recycle rate, 2,000-4,000 cu. ft. per bbl. of charge.

The catalyst (mixed cobalt and molybdenum oxides and alumina) has a life of more than 8 years. Regeneration with steam-air or inert gas-air mixtures restores the catalyst to its original activity.

Yield and cost data. Operating on Iranian kerosine, at 100 psig. and at 780° F., a 99% yield is typically obtained at 70% sulfur removal.

Typical operating costs for a 10,000-bbl. per stream day unit are given in the table. Installation costs for units in the 2,000-20,000-bbl. range vary from $120 to $300 per barrel capacity.

Commercial data. First commercial Autofining unit was installed by British Petroleum in July 1952. Three units are now in operation.

TYPICAL OPERATING COSTS (10,000 BBL. UNIT)

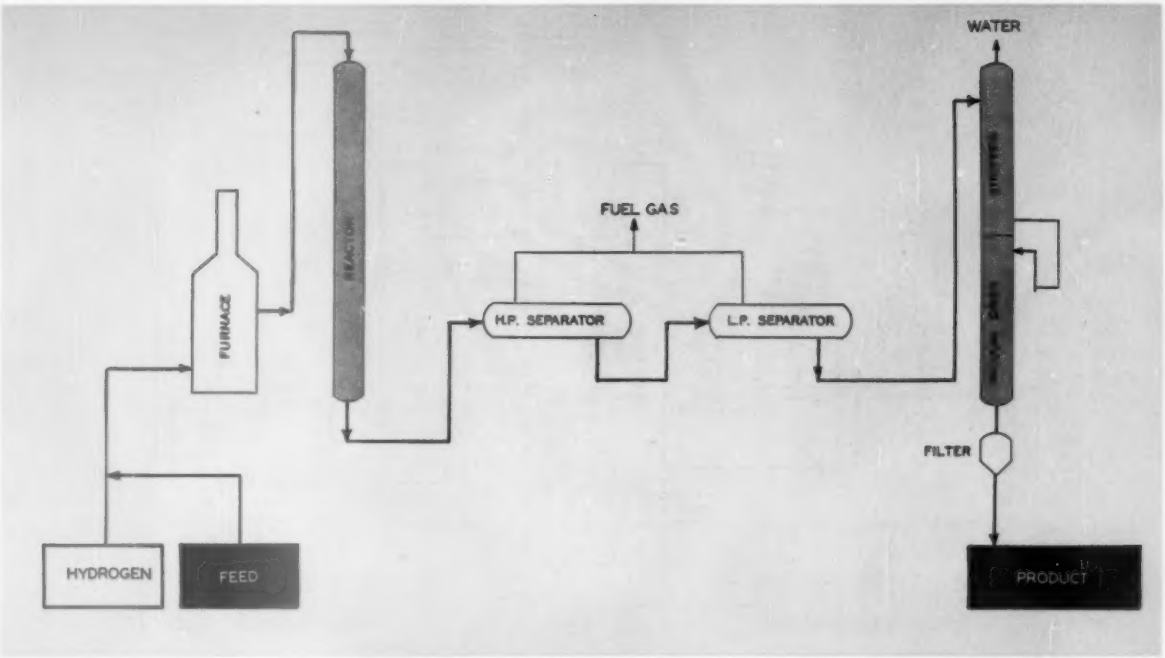
Operating costs, cents per bbl. input	Charge stock: Kerosine	Charge stock: Gas oil
Fuel, $1 per bbl.	2.0	1.8
Power, 8 cents per kw.-hr.	0.8	2.7
Water, 1 cent per 1,000 gal.	0.3	0.3
Steam, 30 cents per 1,000 lb	—1.0	—0.4
Catalyst, $1.25 per lb.	0.6	2.5
Labor, $60 per day and supervision at 15%	2.1	2.8
Total direct operating cost	4.8	9.7
Maintenance, 4% of investment	1.9	2.2
Property taxes and insurance, 2% of invest.	0.9	1.1
Interest (4%), deprec. (10%)	6.6	7.9
Total operating cost	14.2	20.9

TYPICAL YIELDS AND PROPERTIES WHEN OPERATING ON MIDDLE EAST FEED STOCK

	Kerosine‡	Straightrun gas oil
Operating pressure, psig.	100	500
Yield, wt. % on feed	99.0	96.0*
Sulfur removal, %	70.0	92.0

	Feed	Product	Feed	Product
Gravity, °API at 60° F.	39.6	40.2	36.3	38.0
I.b.p., °F.	284	291	482	360
E. p., °F.	50	500	684	671
Sulfur, wt. %	0.8	0.24	1.25	0.1
F-2 octane, clear	52	53	.....	.....
Diesel index	.....	.....	60	60

*1.4 wt. % light ends not included. ‡Including 10% cat. cracked component.



Ferrofining

FERROFINING was developed by British Petroleum Co., Ltd., for hydrotreating lubricating oils, including both solvent-refined oils and straight distillate lubes which normally received acid and clay treatment.

The process consists essentially of passing the lubricating oil and hydrogen through a fixed bed of catalyst, under moderate temperature and pressure. Treated oils have stabilities superior to those obtained when commercially available hydrotreating catalyst are used.

Process features. Ferrofining units can be operated at pressures below those of catalytic reformers; thus it is possible to operate without gas compressors. Only a small amount of hydrogen is consumed; 25 std. cu. ft. per bbl. on the average. Under normal circumstances hydrogen recycle is unnecessary.

The catalyst is a rugged, three-component catalyst on an alumina base. Only infrequent regeneration is required, if at all. In pilot-plant operations, treating various oils, a charge was in continuous operation for 13 months without any sign of reduced activity. Full activity was restored by a simple burnoff with steam-air mixtures.

Flow consists of heating the oil and hydrogen-rich gas to treatment temperature and then charging the stream to the downflow reactor (see diagram). Oil and gas are then separated in two stages. Gas from both stages passes to refinery-fuel mains. Second-stage oil is stripped with steam and dried in a vacuum column to obtain a product of the required flash point.

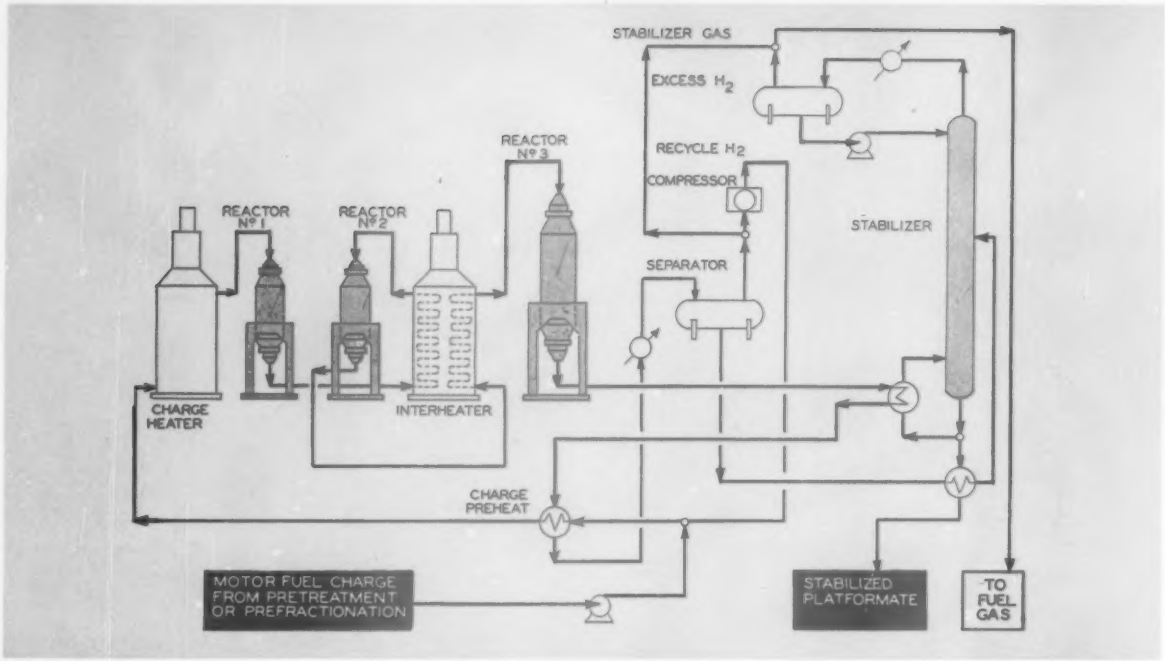
Operating conditions for optimum quality of product vary according to the viscosity of the oil, degree of refining, and origin of the crude. Operating temperature and pressure also are functions of feed-stock type. The operation is carried out at such temperatures, however that, very little desulfurization occurs and hydrogen sulfide production is low. The reactor section thus can be constructed of carbon—½ % molybdenum steel.

Economics. Approximate investment cost for a 3,100-bbl. per stream-day plant in northern France is $495,000. This includes the initial catalyst charge and plant spares, but does not include offsite facilities or any provision for local taxes.

Estimated operating costs of the 3,100-bbl. Ferrofining unit are given in the table. The 19.7-cents per barrel cost is considerably less than that of the clay used in conventional finishing—treatment processes.

ESTIMATED OPERATING COST
(Northern France location; basis of 330 operating days)

	$ per stream day
Depreciation:	
At 10% of process-unit erected cost	125
Labor and supervision:	
2 operators/shift (4-shift basis)	74
Supervision	25
Catalyst:	
Ferrofining catalyst (assumed life 2 years)	97
Hydrogen:	
25 std. cu. ft. per bbl. = 77.5 M.s.c.f.d. at FOE	11
Maintenance:	
Materials and labor at 3% of process unit erected cost	37
Utilities:	
Fuel: 6.7×10^6 B.t.u./hour liberated (= 365 lb./hour) = 26.65 bbl. at $3.00/bbl.	77
Steam: 5.4×10^3 lb./hour at $1.10/1,000 pounds	143
Cooling water: (18° F. temperature difference): 11.6×10^3 U. S. gal./hour at 1.3 cts./1,000 gal.	3
Power: 2,100 Kw. at 0.95 cents/Kw.-hour	20
Estimated total operating cost (before interest, taxes, royalty, and overheads)	$612
Total per barrel cost	19.7 cents



Platforming

THE PLATFORMING PROCESS is the pioneer reforming process successfully employing a platinum-containing catalyst to produce high-octane-number motor fuels or aviation-gasoline components from refinery naphthas of much lower octane number. High yields of aromatic concentrates from select naphtha cuts for subsequent recovery also are obtained.

The process produces hydrogen, which often is the most economical source of this material for other refinery or petrochemical processes. Improved catalysts have recently become available which are specifically tailored for use in the production of clear research-octane-number gasolines of 100 and above.

Platforming is carried out at temperatures ranging from 850° to 1,000° F. and pressures of 200 to 700 psi. In general, the lower ranges of pressure are used for production of aromatics, while intermediate and higher pressures are employed for octane improvement.

COMMERCIAL PLATFORMING OF KUWAIT NAPHTHA

	Charge*	Product†
Gravity, °API	58.2	51.3
ASTM distillation, °F.:		
I.b.p.	215	100
10%	232	138
30%	248	188
50%	264	238
70%	291	283
90%	318	327
E.p.	349	390
R.v.p., psi.		6.4
Sulfur, wt. %	0.04	Nil
Hydrocarbon type analysis, LV %:		
Paraffins	64	
Olefins	Trace	
Naphthenes	23	
Aromatics	13	49
Average yield of 95 oct.:		
Clear reformate		
6-lb. R.v.p., LV % on charge		75.0
Research octane ratings:		
Clear		95.3
With 3 ml. TEL per gal.		102

*Depentanized. †Stabilized.

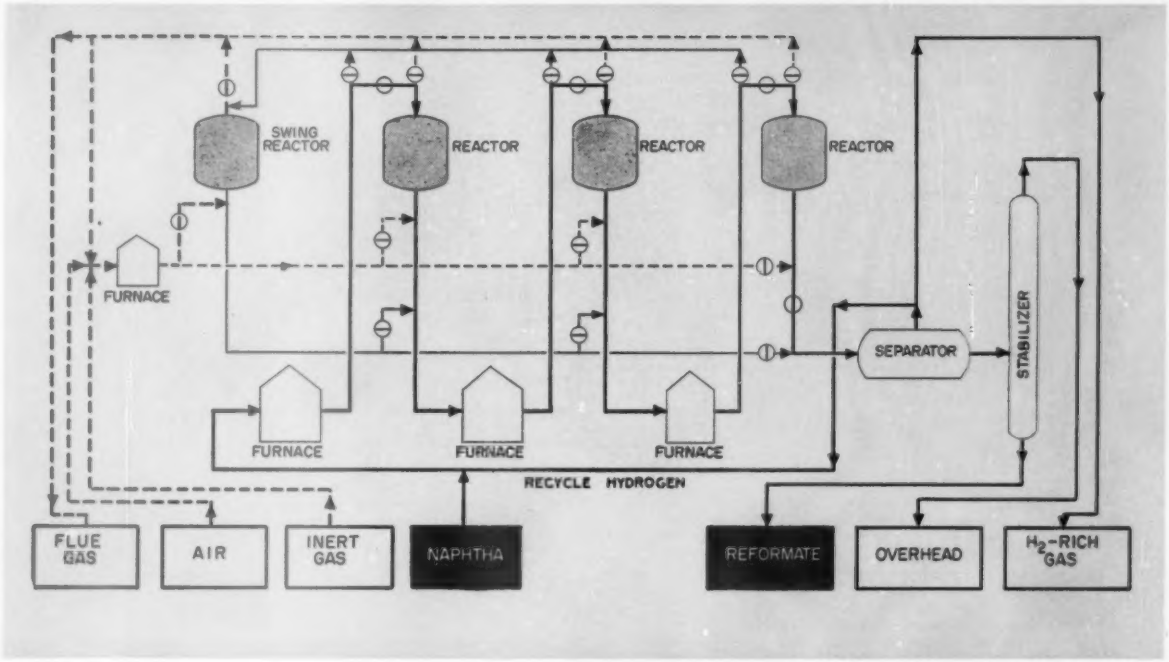
Process reactions. Six principal reactions occur simultaneously during Platforming. These are: (1) dehydrogenation of C_6-ring naphthenes; (2) isomerization of other naphthenes and their dehydrogenation to aromatics; (3) dehydrocyclization of paraffins; (4) hydrocracking; (5) isomerization of paraffins, and (6) desulfurization.

Process flow. The flow diagram illustrates typical equipment and arrangement for Platforming naphtha to produce high-octane motor fuel.

For an aviation-gasoline blending stock, the reformate may be rerun in addition to being stabilized. For aromatics recovery, it is suggested that the reformate be charged to a Udex unit.

Data shown in table were obtained from the commercial Platforming in a standard unit of a Kuwait naphtha, one of the most difficult stocks to upgrade to 102 leaded research octane number.

Yield data. Average yield of 6-lb. R.v.p. reformate during the run was 75 vol. % of reactor charge. Catalyst age reached 45 in this high-severity operation, data for which indicate extreme stability with no evidence of catalyst fouling or excessive hydrocracking. This process is licensed by Universal Oil Products Co.



Ultraforming

ULTRAFORMING is a regenerative, fixed-bed catalytic reforming process to convert low-octane naphthas to high-octane blending stocks.

Objective. The process is especially designed to produce gasoline blending stocks with clear-octane ratings up to 102-104 without the use of auxiliary processes.*

Process features. Ultraforming has several distinctive process features. Frequent on-stream catalyst regeneration is made possible by a unique process design which includes a swing reactor. When catalyst activity in an onstream reactor declines, that reactor is temporarily replaced by the swing reactor.

Reforming operations continue while catalyst in the isolated reactor is regenerated in situ with air and inert gas.

*The Wiese extension of the octane scale is used for octane numbers over 100.

After regeneration, the freshly regenerated reactor is placed back on stream. The swing reactor is again available to replace any other reactor in the system.

Other distinctive Ultraforming features include low reaction pressures and low gas recycle rates.

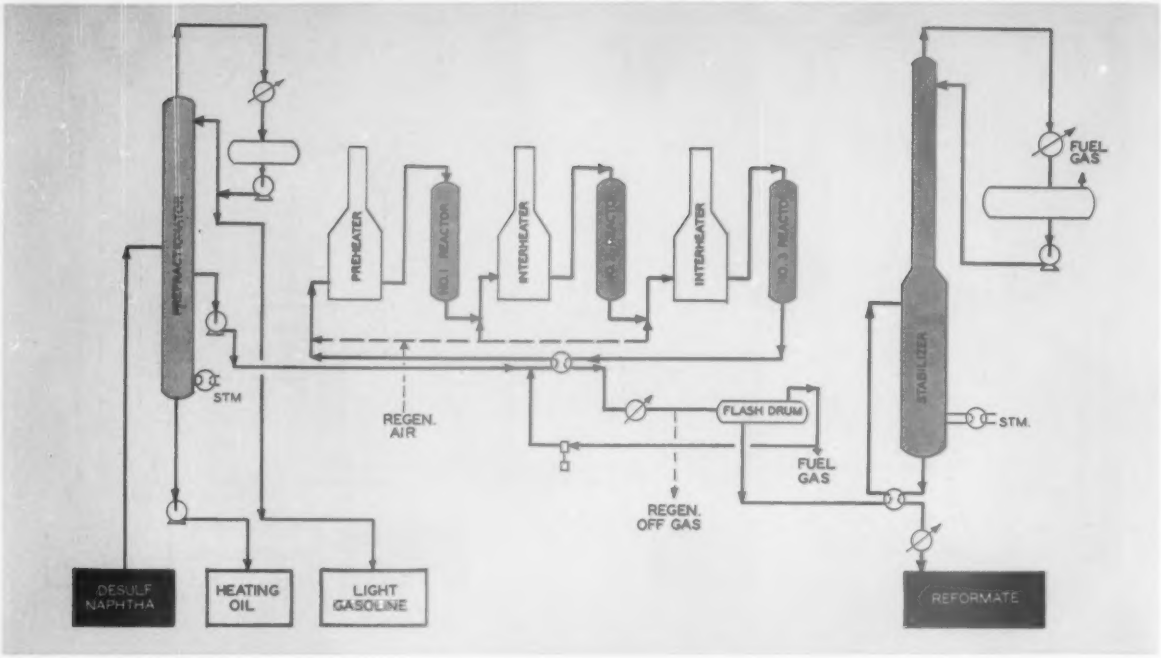
Operating conditions. Usually a reactor pressure of about 200-300 psig. and reactor-inlet temperatures of 900°-950° F. are used. Hydrogen recycle rate and space velocity are adjusted to the particular characteristics of the charge and to the product desired.

Ultraforming catalyst has been successfully regenerated up to 300 times in commercial units. Several commercial installations have now attained catalyst lives between 100-200 bbl. per lb. Catalyst activity and selectivity in these units are still maintained at their initial value.

Commercial data. A total of 25 commercial units of American, its affiliates and licensees, are operating. Ultraforming process licenses are available from American Oil Co. They give operating rights under patents of American and Esso Research & Engineering Co.

ULTRAFORMING YIELDS

	Gulf Coast		Mid-Continent		Kuwait	
CHARGE NAPHTHA						
ASTM Dist., °F.						
I.b.p.	238		200		193	
10%	263		230		220	
50%	304		262		266	
90%	357		316		330	
E.p.	400		362		366	
Composition, vol. %						
Paraffins	35		51.3		68.5	
Naphthalenes	51		36.2		20.5	
Aromatics	14		12.5		11.0	
RON., Clear	42.8		48.4		35	
PRODUCTS						
C_5+ Reformate						
RON., Clear	100	103.5	96	102	95	100
Yield, vol. %	80.9	75.5	80.5	74.4	75.0	63.8
R.v.p., psi.	2.9	3.5	2.8	3.4	5.1	5.9
Butanes, vol. %	5.1	7.1	6.1	8.8	10.8	15.4
Dry Gas, wt. %	8.8	12.2	9.3	12.9	12.7	19.8
Hydrogen, s.c.f. per bbl.	1,330	1,330	1,150	1,150	710	750
10-psi. gasoline						
RON, Clear	100	103.5	98	102	95	100
Yield, vol. %	89.7	81.0	90.3	81.5	80.5	67.4



Catalytic reforming (Sinclair)

THE SINCLAIR catalytic-reforming process and associated catalyst are designed for flexible, efficient processing of any quality naphtha to meet varying product requirements.

Catalyst features. Designated RD-150, the platinum reforming catalyst developed by Sinclair Research Laboratories, Inc., and Baker & Co. (now Engelhard Industries, Inc.) embodies a number of specific advantages.

It is characterized by high naphthalene dehydrogenation and paraffin dehydrocyclization activity, selective isomerization activity, and low hydrocracking activity. It is resistant to permanent poisoning by normal concentrations of nitrogen, water, and sulfur in the feed stock. Its regenerative characteristics provide high activity maintenance over the life of the catalyst, and maintain near virgin yield structure over the normal operating cycle.

Process description. The flow chart illustrates a typical three-reactor reforming design. The reactors are fixed-bed, downflow, adiabatic type, designed to minimize adverse thermal effects.

Pretreatment of the feed is seldom mandatory for satisfactory catalyst performance. However, it is desirable to either pretreat the feed or recycle gas for removal of sulfur compounds to reduce corrosion.

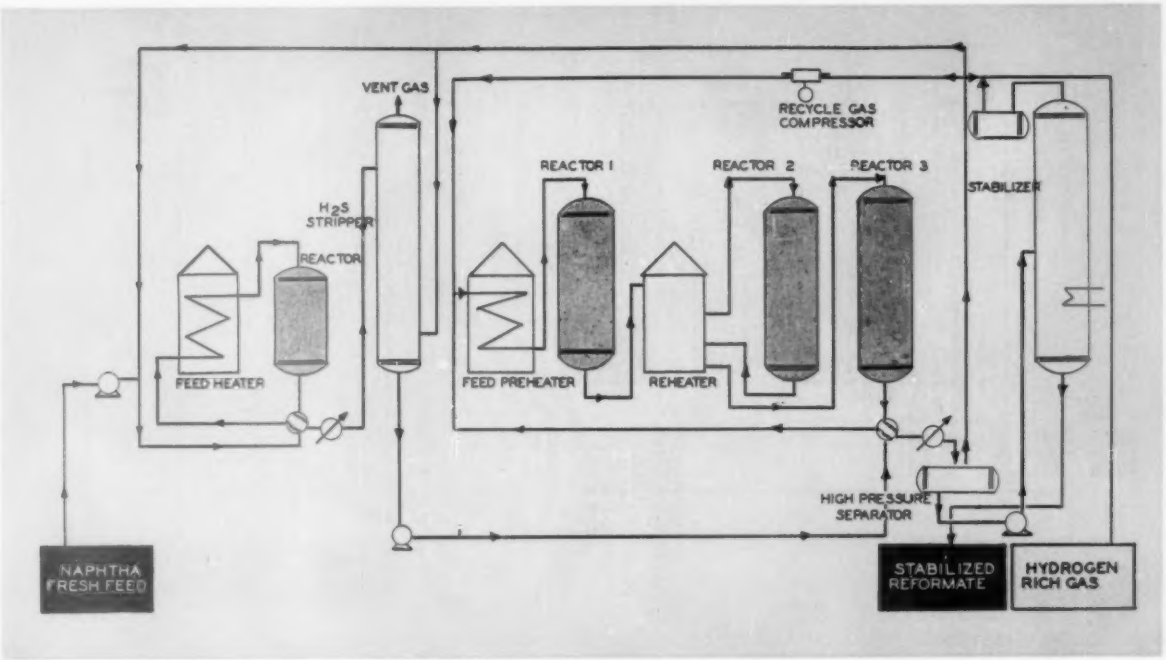
Operating conditions. Typical ranges of operating conditions are: 850° to 1,000° F. reactor inlet temperature, 1 to 4 weight hourly space velocity, 200 psig. pressure, and 3 to 10 molal gas-recycle ratio. On motor-gasoline operation, a blending stock of 85-100-plus research clear octane number may be produced as a function of the conditions used.

Commercial data. Total domestic and foreign RD-150 reforming capacity is in excess of 550,000 bbl. per stream day. Sixty-three units use the catalyst, while an additional ten units are under design or construction.

RD-150 catalyst is supplied by Engelhard's chemical division, which also processes the used catalyst for platinum recovery. Foreign customers are supplied by Kali-Chemie-Engelhard, Neinburg, Germany.

CATALYTIC REFORMING WITH RD-150 CATALYST

Crude type—	Middle East					
Feed stock inspections:						
API gravity	62.3					
ASTM distillation, °F.						
I.b.p.	204					
10%	210					
50%	**222**					
90%	251					
E.p.	273					
Type analysis, vol. %:						
Paraffins	61.5					
Naphthenes	30.2					
Aromatics	8.3					
R.O.N. clear	46.9					
R.O.N. + 3 cc TEL	71.3					
Yields						
Operating Conditions:						
Pressure, psig.	—500—		—350—		—200—	
R.O.N. Clear	95	100	95	100	95	100
H_2 wt. %	1.2	1.3	1.6	1.7	2.1	2.3
C_1 wt. %	2.7	3.7	2.2	3.1	1.6	2.4
C_2 wt. %	5.2	7.1	4.3	5.8	2.9	4.6
C_3 wt. %	7.7	10.3	6.3	8.5	4.3	6.7
iC_4 vol. %	5.2	7.0	4.3	5.7	3.0	4.5
nC_4 vol. %	6.5	8.7	5.4	7.1	3.8	5.7
C_5-e.p., vol. %	69.8	59.2	73.1	63.6	78.0	69.0
R.v.p., lb.	5.8	6.3	5.0	5.4	4.1	4.5
ASTM distillation:						
I.b.p.	117	113	119	115	122	116
10%	162	157	165	160	177	172
50%	226	231	227	232	230	234
90%	280	284	282	286	284	288
E.p.	318	324	319	325	320	326
R.O.N. + 3 cc TEL	101.4	104.5	101.4	104.5	101.4	104.5



Houdriforming

HOUDRIFORMING is a fixed-bed catalytic process designed to reform a variety of straightrun or cracked naphthas, having substantially different compositions.

Process characteristics. Here are the outstanding characteristics of Houdriforming:

1. Naphthas with end boiling points up to 400° F. may be charged.

2. Low-octane naphthas may be efficiently upgraded to very high octane levels with high volumetric recovery.

3. Depending upon feed composition and type or severity of operation, aviation blending stocks, aromatics, and high-octane motor stocks may be produced.

4. With the "guard case" integrated with the Houdriformer, high-sulfur or nitrogen-bearing feed stocks are readily handled without resorting to scrubbing of recycle gases, and

5. Stabilized reformates require no additional treatment.

6. At moderate severities Houdriforming may be operated without catalyst regeneration. If high-severity is required, Houdriforming lends itself to simple in-place regeneration, as has been commercially practiced on numerous occasions.

7. When operating for aromatics, appropriate naphthenes are converted to benzene, toluene, and xylenes at yields approaching 100% of theoretical values, with significant aromatization of paraffins.

Houdriforming capacity in operation or under construction, ranging from 500 to 45,000 bbl. per stream day, plus other reforming capacity using Houdriformer catalyst amounts to about 247,000 bbl. per stream day.

Operating conditions. Temperature, 875°-990° F.; pressure, 250-600 psig.; space velocity, 1.5 to 5.0 vol./hour/vol.; hydrogen-to-oil mole ratio, 4/10.

TABLE 1—HOUDRIFORMING FOR MOTOR GASOLINE

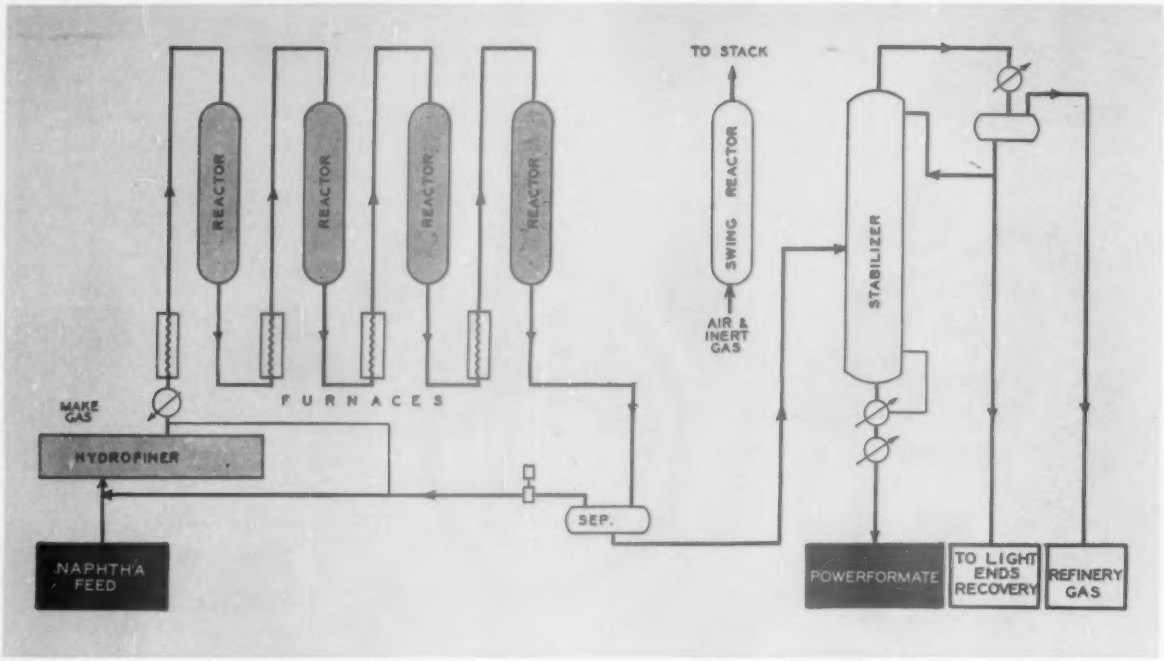
Yield of debutanized reformate Vol. % of charge	Octane No. F-1 + 3 cc TEL
94.4	93.9
91.9	96.9
90.3	98.3
87.5	100.0

Reformate inspection—	Naphtha charge	Reformate
Gravity, °API	52.6	47.7
Distillation, °F. I.b.p.	198	114
10	222	188
30	242	228
50	264	256
90	340	340
e.p.	376	406
F-1 octane clear	54.6	89.5
F-1 octane + 3 cc TEL	76.2	98.5
Composition (depentanized basis):		
Paraffins	42.7	39.1
Olefins	0.7	1.1
Naphthenes	37.8	3.4
Aromatics	18.8	56.4

TABLE 2—HOUDRIFORMING FOR AROMATICS

Type of operation	Benzene-Toluene	Xylene
Charge composition, vol. %		
Paraffin	49	52
Naphthenes	44	40
Aromatics	7	8
Charge rate, bbl. per day	12,500	10,000
Yields:		
Stabilized product, vol. %	90.8	87.0
High pressure gas, S.c.f. per bbl.	1,120	1,140
Product composition, vol. %		
Paraffins	53	52
Olefins	0	0
Naphthenes	4	0
Aromatics	43	48
Hydrogen purity of high-pressure gas	97	95.5
Net aromatics yield vol. % of charge	32.0	33.8
Net aromatics, per cent of theoretical	87	101

Note: These yields were established by surveys of plant performance after 5 months' catalyst life.



Powerforming

POWERFORMING is a fixed-bed catalytic reforming process, using a platinum catalyst, for upgrading low-octane naphthas to high-octane motor-gasoline components. It also can be operated to produce aviation blending stocks, or to give high yields of aromatics.

Charge stocks. Typical feed stocks consist of low-octane naphthas in the boiling range of 160° to 400° F. Where more favorable stocks are used, or where only moderate octane improvement is required, an intermittent regeneration system is used. In this type Powerformer, the unit is taken off stream at intervals of 2 to 6 months and all reactors are regenerated.

With poorer feed stocks or for the production of high-octane products (to 100 Research octane number clear or higher), a cyclic regeneration system is used. In this case reactors are regenerated individually without taking the unit off stream. The additional "swing" reactor provided is used to replace each on-line reactor as its catalyst is regenerated.

Process flow. In addition to the reactor system, Powerformers include a feed Hydrofiner. After stripping to remove hydrogen sulfide, the feed is combined with hydrogen-rich recycle gas from the separator drum (see diagram).

This mixture then flows through the series of reactors, each of which is preceded by a fired heater. Effluent from the last reactor is cooled and run to the separator. Powerformate from the separator is stabilized in conventional equipment.

Blocked operations can be used to provide Powerformate specifically tailored for a refiner's regular and premium grade.

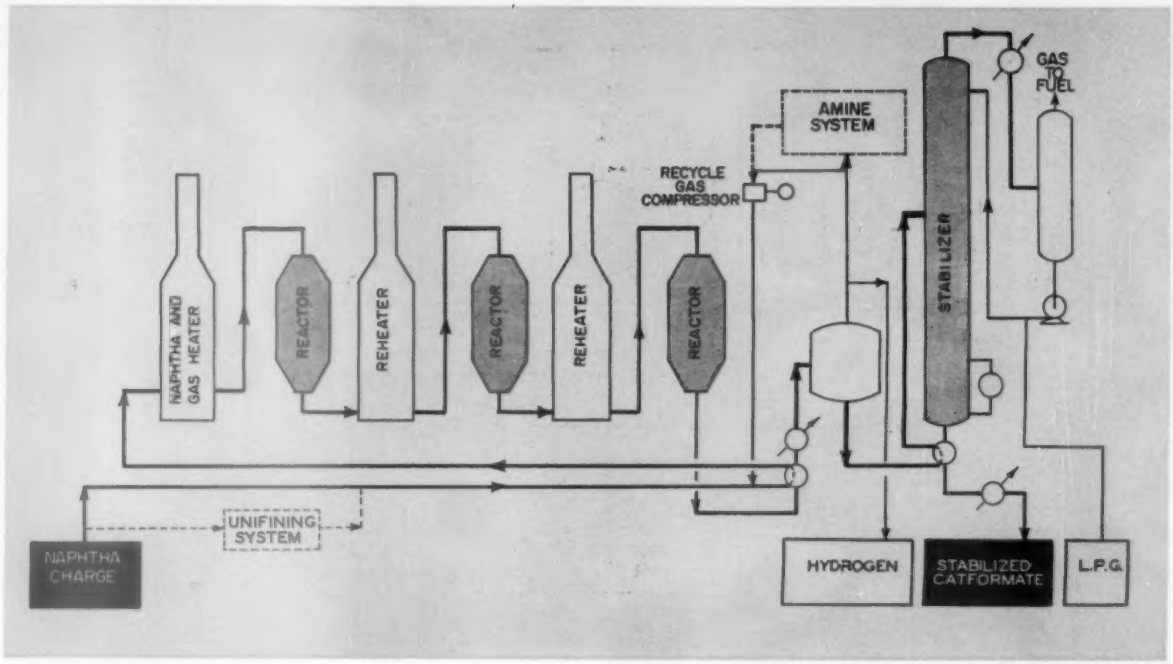
Also, a special arrangement of light-ends facilities can be incorporated to obtain C_3 recoveries greater than 90% and C_4 recoveries of 99+%.

Yield data. Typical yields and product specifications are given in the table. Large volumes of hydrogen also are produced, which may be used to desulfurize the feed and to treat other refinery products. The rugged supported platinum catalyst maintains high activity and selectivity over long periods of operation.

Commercial data. Thirty-four Powerforming units are now in operation or under construction, ranging in capacity from 2,000 to 26,000 bbl. per stream day. Total capacity of these units is approximately 320,000 bbl. Powerforming was developed and is licensed by Esso Research & Engineering Co.

POWERFORMING OPERATING RESULTS

Feed properties:				
Feed source	Arabian	Arabian	Mixed La.	W. Tex.
Gravity, °API	61.6	49.6	55.0	53.0
Research O.N. clear	42	26	58	56
ASTM 5% point, °F.	190	310	223	235
ASTM 50% point, °F.	236	342	253	260
ASTM 95% point, °F.	294	380	304	291
Watson K factor	12.1	11.9	11.8	11.7
Yields,				
C_5+, vol. %	64.3	78.3	77.5	81.0
H_2, wt. %	1.3	1.3	2.1	2.0
C_1, wt. %	2.3	1.3	1.7	1.5
C_2, wt. %	5.9	2.8	2.9	2.5
C_3, wt. %	10.0	5.7	5.1	4.4
C_4, vol. %	15.0	8.4	8.8	7.8
C_5+ reformate properties:				
R.v.p., psi.	6.7	4.2	4.0	3.1
Octane numbers:				
F-1 clear	100	100	100	100
F-1+3 cc. TEL	104.3	103.5	103.9	103.9
F-2 clear	89.9	89.9	89.6	89.5
F-2+3 cc. TEL	95.5	94.4	94.8	94.6



Catforming

CATFORMING produces high-octane gasoline and aromatics from low-quality naphthas, with minimum operating and investment costs. Yield distribution is distinctive and is especially valuable to the refiner desiring byproduct LPG or isobutane.

The Catformer process can be applied to widely different feed stocks, including light naphtha, full-boiling-range naphtha, or heavy-naphtha reformer feeds.

Charged properties. The Atlantic-16 reforming catalyst used in the process is built on a silica-alumina carrier. Carbon deposition is very gradual. After an extended run, the catalyst may be restored in activity by burning the carbon deposit in a combustion stream of low oxygen content.

This ability to regenerate simply and quickly in place, with no special equipment required, also saves considerable catalyst life if a major upset lays down a heavy carbon deposit. Catalyst life extends through several regeneration cycles before a change of catalyst is required.

Atlantic-16 catalyst is supplied and licensed by Engelhard, Inc. As the company also manufactures and licenses use of RD-150 platinum-alumina-type reforming catalyst, a refiner may now use either of these distinctive types of catalysts under a single license agreement. Both catalysts are adaptable for interchangeable use in a given design unit.

... Process flow is diagramed in the chart. Reheaters provided between the reactors supply the heat consumed in aromatics formation. Recycle hydrogen is compressed and returned to the reactors, with the net hydrogen production being vented (under pressure control) from the unit.

High-sulfur stocks may be reformed at low or moderate severity without feed pretreatment. Desulfurization is accomplished by conventional scrubbing of the recycle gas in an amine absorber. For high-severity operation, a hydrogen pretreating unit is recommended as indicated on the flow chart.

Operating conditions. Reactor temperature ranges from 850° to 1,000° F. Pressure is maintained at 300 to 700 psig. The process is flexible so that a range of product yields and quality is readily obtainable by simple adjustments to operating severity.

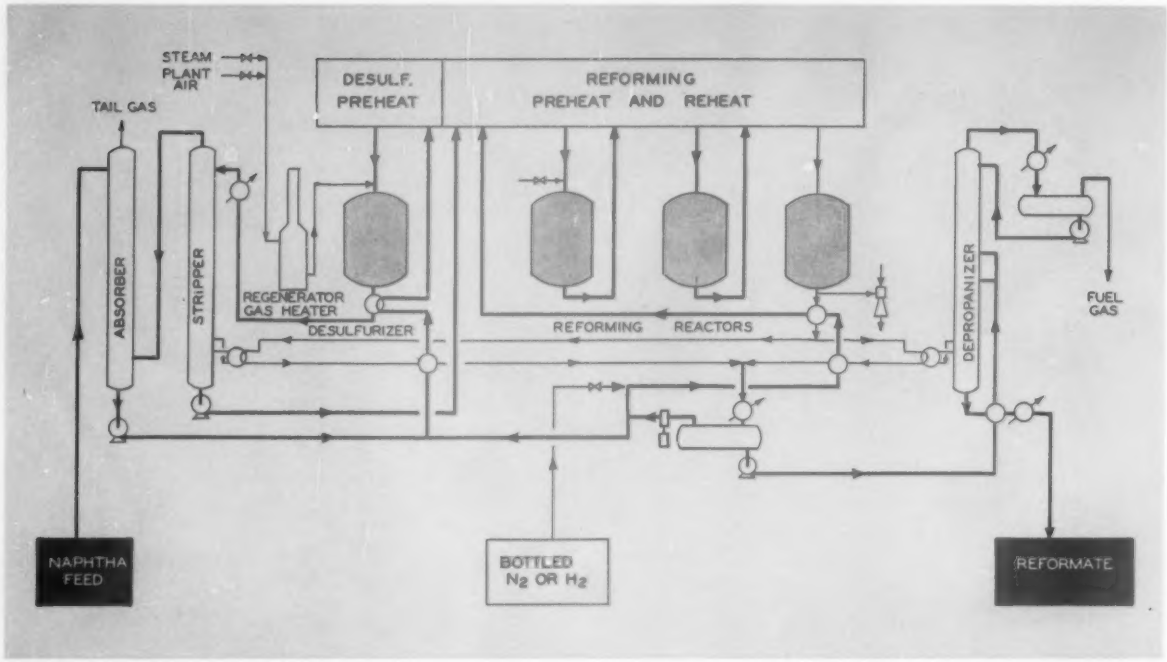
Commercial data. Units operating in many different countries range in capacity from 500 to 15,000 bbl. daily. Catforming was developed and is licensed by Atlantic Refining Co.

RESULTS FROM CATFORMING NARROW AND WIDE-CUT FEEDS

	Stock A	Stock B
Feed properties:		
F-1 octane, clear	46.9	31.0
°API	62.3	58.9
ASTM dist., °F.:		
10%	210°	208
50%	222°	275
90%	251°	361
Vol. % paraffins	61.5	69.0
Vol. % naphthenes	30.2	18.0
Vol. % aromatics	8.3	13.0

Product yield and properties:

	Low Severity	High Severity	Low Severity	High Severity
Product yield and properties:				
C_5+ reformate, F-1 clear	85.0	95.0	85.0	95.0
C_5+ reformate, F-1 3 cc.	96.9	102.4	95.7	101.2
C_5+ reformate, vol. % yield	82.1	68.9	78.9	69.5
Light hydrocarbon yields:				
Normal butane, vol. %	5.3	8.9	7.5	8.5
Isobutane, vol. %	4.2	7.0	5.9	6.5
Propane, wt. %	4.2	8.1	5.3	8.5
Ethane, wt. %	1.3	2.7	1.4	2.6
Methane, wt. %	0.9	1.9	0.9	1.4
Hydrogen, wt. %	0.9	1.0	0.5	0.6



Catalytic reforming, desulfurization (Kellogg)

THIS COMBINATION PROCESS, designed by M. W. Kellogg Co., permits the reforming of low-grade naphthas to aromatic high-octane gasoline. Cobalt molybdate catalyst is used for the desulfurization step, and a platinum-containing catalyst is used for the reforming operation.

Light, heavy, and full-boiling-range virgin naphthas, including those from high-sulfur crudes are acceptable feed stocks. Catalytically and thermally cracked naphthas may also be handled; these stocks require more severe conditions in the desulfurization section.

The product is a premium or aviation gasoline having an F-1 clear octane number ranging from 85 to over 100, depending upon requirements. This reformate is a rich source of pure aromatics. The process also provides significant amounts of isobutane for alkylation and hydrogen for the upgrading of other refinery streams.

Description. A typical combination unit designed to produce 95 to 100 F-1 clear-octane reformate consists of three principal parts: a pretreat or catalytic desulfurization section, the reforming section, and the catalyst-regeneration equipment.

The reforming section may be composed of up to five reactors; the first three are connected in series, and the last two are in parallel. Reheat furnaces are interposed between reaction steps.

Operation cycles are a function of feed characteristics and reforming severity.

Regeneration. Catalysts are regenerated in place. When onstream regeneration facilities are included in the reforming section, any one of the terminal reactors may be shut down with no significant disturbance to the over-all operation. Units not so provided are regenerated during the turnaround.

The pretreating section usually contains its own steam-air-regeneration equipment; the cobalt molybdate catalyst is also regenerated during turnaround.

Operating data. Reformer operating pressures range generally from 200 to 500 psig., temperatures from 875° to 970° F., and recycle gas rates of 5 to 8 M.s.c.f. per bbl. naphtha feed. Conditions for the cobalt-molybdate pretreat section range from 350 to 800 psig., 675° to 750° F., and 400 to 1,500 std. cu. ft. per bbl. naphtha charge.

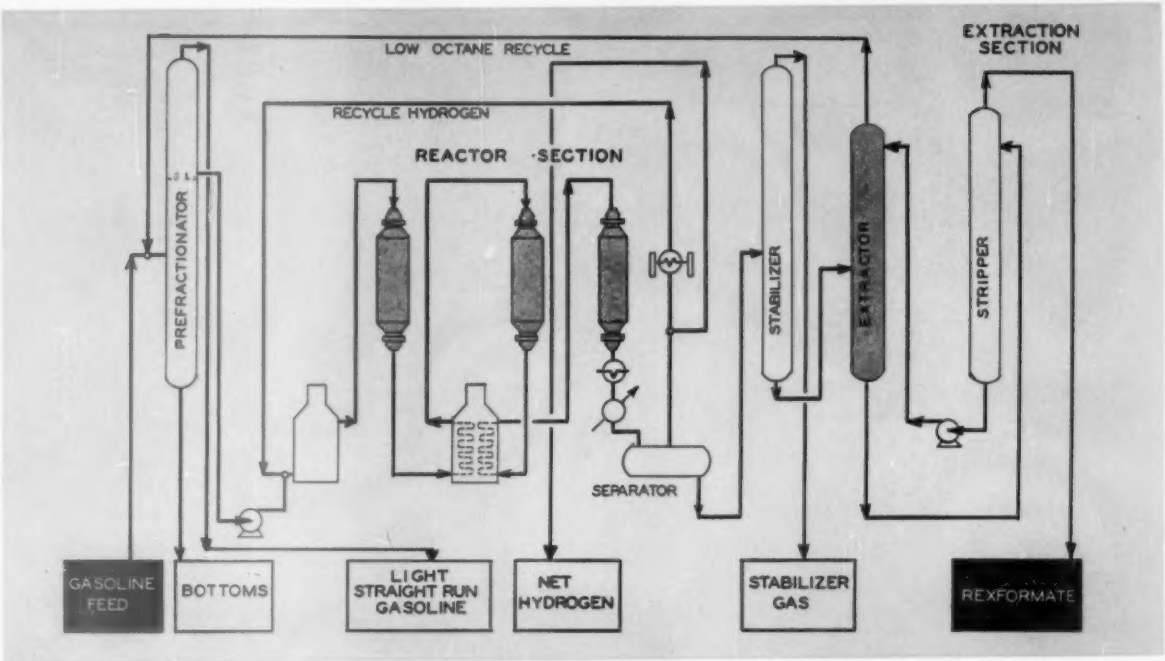
Commercial data. Installation costs for these combination units are from $125 to $350 per barrel for charge capacities from 3,000 to 30,000 bbl. per stream day. Average operating costs for a 10,000 bbl. per stream day unit are given in Table 2. Installations designed or constructed by Kellogg include 28 units with over 227,000 bbl. capacity.

TABLE 1—TYPICAL YIELDS

Feed Stock—	Mid-Continent		Kuwait	
Gravity, °API	54.6		57.2	
Paraffins, vol. %	51.0		59.7	
Naphthenes, vol. %	38.3		24.6	
Aromatics, vol. %	10.7		15.7	
Reformate—				
F-1 clear octane	95	100	95	100
Yield C_5 + reformate, vol. %	81.4	76.9	78.2	73.2
Yield C_4's, vol. %	6.2	7.8	7.2	8.8
Yield dry gas, wt. %	9.8	12.3	10.4	12.8

TABLE 2—TYPICAL OPERATING COSTS

Feed Stock—	Mid-Continent		Kuwait	
C_5 + product octane, F-1 clear	90	95	90	95
Direct operating cost, cents per barrel feed	13.8	16.5	16.6	21.3
Total operating cost, cents per barrel feed	25.7	29.3	28.8	35.4



Rexforming

THE REXFORMING PROCESS combines elements of both the Platforming and the Udex solvent-extraction processes to make a reformate testing above 100 unleaded research octane number from full-boiling-range gasoline.

The low-octane paraffinic raffinate is continuously recycled with fresh feed. Alternatively, all or a part of the raffinate may be withdrawn, as for use in jet fuels. Processing is considered of moderate severity and high-purity aromatics are not recovered as such.

Process flow. The flow diagram shown is labeled to indicate the combination of Platforming and Udex processes. A feature of the process is that the solvent-extraction conditions can be adjusted to include desired amounts of low-boiling paraffins and naphthenes in the reformate, along with the aromatics, to help produce a well-balanced motor fuel.

Yield data. Table 1 illustrates the Rexforming of a West Texas straightrun naphtha in contrast with such a refractory stock as a Middle East naphtha.

Table 2 shows estimated investment and operating costs for a 5,000-bbl. per stream day unit processing a full-boiling-range Mid-Continent gasoline.

Economic data. Several units are in commercial operation in the United States, which range in capacity from 1,500 to 6,000 bbl. per stream day. Numerous Platformers contain provisions for future conversion to Rexforming. The process was originated and developed by Universal Oil Products Co., which licenses the process.

TABLE 1—REXFORMING OF LOW-OCTANE NAPHTHAS

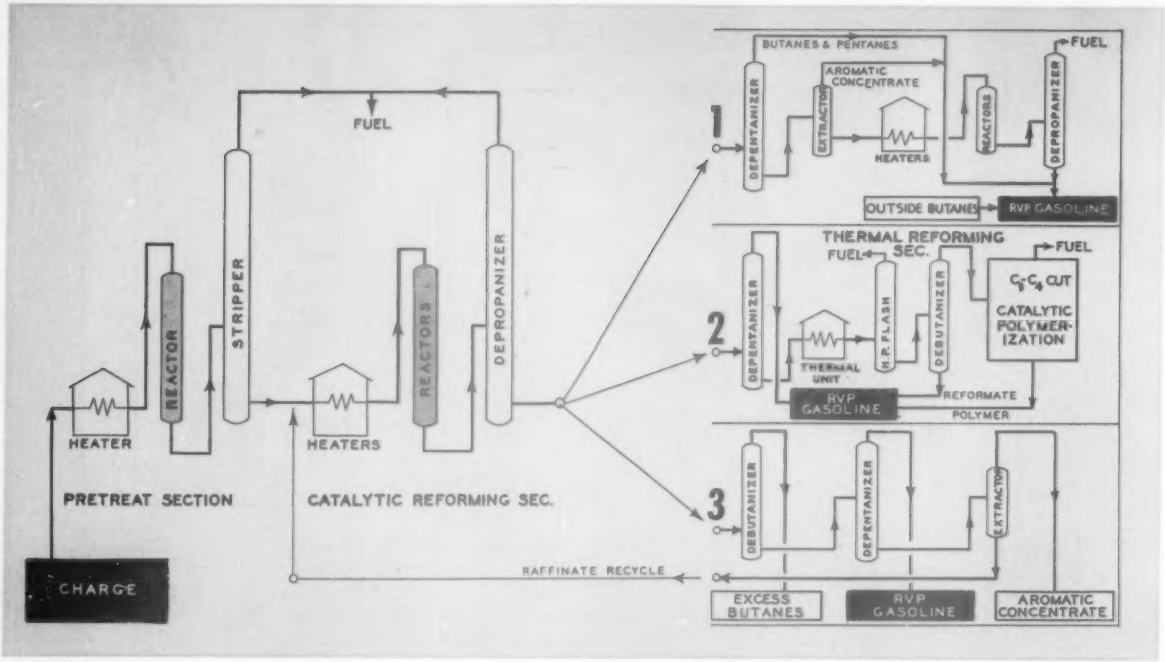
	West Texas*		Middle Eastern†	
	Reactor charge	Reformate‡	Reactor charge	Reformate‡
Gravity, °API	56.4	...	57.4	45.4
ASTM dist., °F.:				
I.b.p.	168	149	204	121
10%	184	184	236	163
30%	214	...	259	230
50%	244	258	282	275
70%	286	...	304	304
90%	328	338	334	345
End point	390	394	386	418
Research clear octane	52.5	§98.2	...	98.0
Aromatics vol. %	9.7	64.2	12	58.8
Naphthenes, vol. %	36.1	....	19	....
Yields, charge basis: Liq. vol. % charge:				
Debutanized ref.	....	79.0	...	75.6
10-lb. R.v.p. reformate	....	....	....	84.7

*Commercial operation. †Pilot plant. ‡Properties and yields are for debutanized reformate except for 10-lb. R.v.p. gasoline yield. §Wiese octane-scale extension; 103.4 with 3 ml. TEL/gal.

TABLE 2—ESTIMATED OPERATING COSTS, 5,000-BBL. PER STREAM DAY UNIT

	Cents/bbl.
Operating costs:	
Labor at $2.75 an hour	4.2
Laboratory	1.0
Utilities:	
Fuel at 25 cents per M.M. B.t.u.	†14.3
Power at 0.8 cent per kw.-hr.	1.6
Steam at 50 cents per 1,000 lb.	2.7
Water at 1 cent per 1,000 gal.	1.3
Catalyst	5.0
Solvent	1.6
Maintenance, taxes, etc.	6.2
Total operating costs‡	37.9

*4,300-bbl. per stream day fresh naphtha charge to reactor section. †No credit taken for fuel gas make. ‡Excludes royalty, depreciation, administration, and overhead.



Iso-Plus Houdriforming

ISO-PLUS HOUDRIFORMING couples conventional catalytic Houdriforming with supplemental thermal reforming or aromatics extraction to convert low-octane naphthas into gasoline in the range of 100 octane and higher, F-1 clear, at high yields.

Commercial runs of Iso-Plus Houdriforming in the thermal reforming alternative have produced motor gasoline of 104 octane, F-1 clear.

Experimental runs of Iso-Plus aromatics-extraction variations have produced yields of 100-octane F-1 clear gasoline amounting to 91% of naphtha charge. With slight operational modifications, one aromatics extraction variation has produced 82 vol. % of charge as 108-octane gasoline, F-1 clear.

An Iso-Plus Houdriforming unit consisting of the world's largest Houdriformer (45,000 bbl. per stream day) and an aromatics-extraction unit has been successfully operating since February 1957, during which time motor fuels in the 100+ octane range were and are still being produced. The Houdry reforming catalyst in this unit thus far has a life of over 250 bbl. per lb.

Catalyst. Each of the alternatives begins with Houdry "guard case" pretreatment of charge, and proceeds with mild conventional catalytic Houdriforming. As shown in the flow diagram, Iso-Plus Houdriforming with supplemental thermal reforming adds the cat poly gasoline from the thermal reformer offgas olefins to get the maximum yield of product at the 100 F-1 clear octane levels.

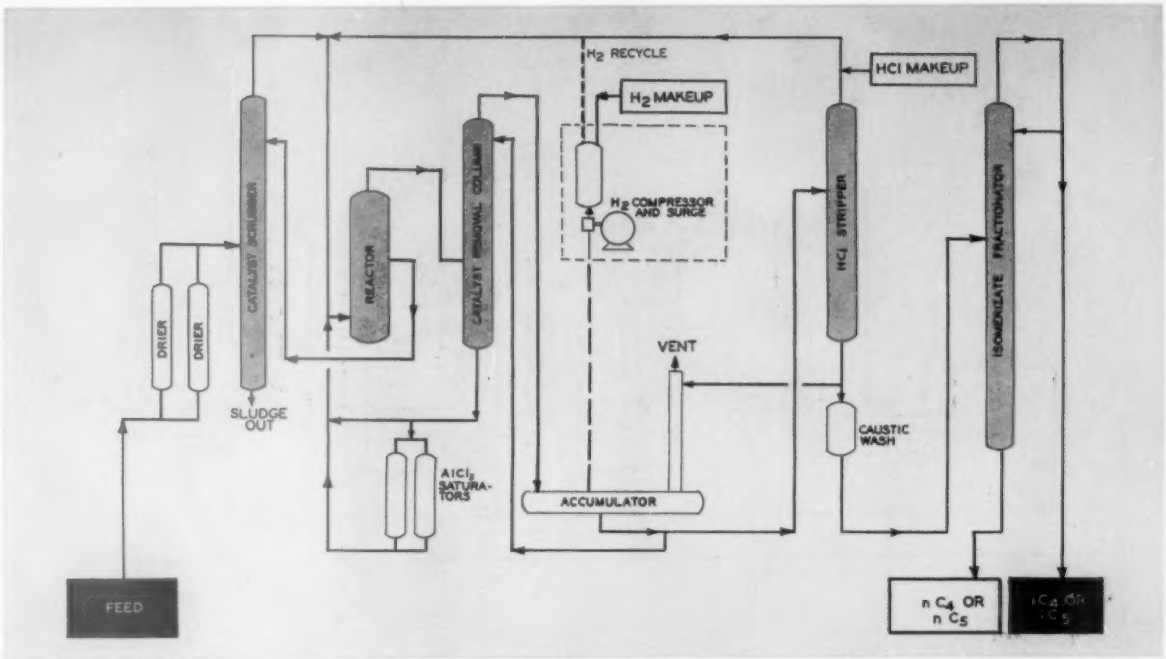
In the aromatics extraction variations, Iso-Plus processing may employ either separate Houdriforming installations with the second reforming unit handling raffinate from aromatics extraction, or a single three-chamber Houdriformer with mixed feed consisting of naphtha charge and recycled raffinate from the extraction unit.

Table 1 presents comparative yields by two routes in Iso-Plus Houdriforming charging a 200°-394° F. naphtha containing 46% paraffins.

TABLE 1—COMPARATIVE YIELDS AND PROCESS STREAMS OF ISO-PLUS HOUDRIFORMING PROCESSES

	Houdriforming plus aromatics extraction		Houdriforming plus thermal reforming
Feed to pretreater (b.p.s.d.)	6,600	6,600	6,600
Recycle raffinate		3,531	
Total reformer feed	6,600	10,131	6,600
Yields from reforming:			
Reformate, C_5+	5,003	8,753	5,900
Butanes	271	574	271
Fuel gas, FOE	422	818	422
Reformate octane, F-1 clear	87.0	83.0	87.0
Charge to debutanizer		9,327	6,171
Charge to dependanizer	6,171	7,068	
Dependanizer bypass stream		1,685	
Extraction charge	5,603	6,545	
Aromatic concentrate	3,174	3,014	
Raffinate	2,429	3,531	
Yields from second pass reforming:	Houdriformer raffinate		Thermal reformer reformate
Reformate, C_5+	1,932		4,807
Heavy polymer			33
Butanes	246		143
Butenes, recovered for cat. poly chg.			273
Propene, recovered for cat. poly chg.			183
Fuel gas, FOE	293		491
Reformate octane, F-1 clear	81.0		99.6
Catalytic polymer gasoline			328
Over-all yields:			
Butane free gasoline	5,403	5,222	5,135
Butanes for 10-lb. R.v.p.	590	529	536
Total 10-lb. R.v.p. gasoline	5,993	5,751	5,671
Excess butanes	*73	45	*122
Fuel gas, FOE	715	818	913
F-1 clear octane of 10-lb. R.v.p. gasoline	100.0	100.0	100.0

*Outside butanes required.



Liquid-phase isomerization

IN THE SHELL liquid-phase isomerization process, normal butane or normal pentane is contacted in the liquid state with a catalyst consisting of aluminum chloride dissolved in molten antimony trichloride.

Process flow. When isomerizing n-butane, the feed is dried at ambient temperature, heated, and passed through a catalyst-scrubber column. It is then charged into the reactor.

A liquid-liquid extraction of a small sidestream of catalyst from the reactor with hot feed takes place in the scrubber. The valuable active catalyst components pass back to the contactor in solution. The fluid inactive $AlCl_3$-hydrocarbon complex, which forms as a consequence of the small amount of side reactions and the presence of feed impurities, runs to the bottom of the column and is periodically drained off.

The butane with dissolved recycle HCl is then contacted in the reactor with a solution of $AlCl_3$ in molten $SbCl_3$. A relatively short residence time in the reactor is sufficient to achieve a high conversion—exceeding 60% for butane and 70% for pentane. After phase separation from the catalyst in an upper settling section of the reactor, the isomerizate flows to the catalyst-removal column for separation of dissolved catalyst by a simple fractionation.

The recovered catalyst is pumped back to the reactor. The isomerizate is taken overhead, condensed, and pumped to the HCl stripper where the acid gas is removed and recycled to the reactor. The isomerizate, thus essentially freed of HCl, is given a caustic wash and sent to subsequent operations.

Pentane isomerization. When isomerizing n-pentane, the reaction is effected in the presence of a small amount of hydrogen (see inset on flow diagram). Purpose of the hydrogen is to suppress disproportionation reactions. Bulk of the hydrogen is recycled from the catalyst-removal-column accumulator. However, some passes in solution to the HCl stripper and is recycled with the HCl. The small amount of uncondensable gas formed is vented from the catalyst-removal-column accumulator through a scrubber.

Operating conditions. Typical operating conditions for isomerizing n-butane and n-pentane are as follows:

	Butane	Pentane
$AlCl_3$ content of catalyst, wt. %	8	3
Temperature in contactor, °F.	176-194	176-212
HCl concentration in feed, wt. %	5	5
Operating pressure, contactor, psig.	300	300
H_2 concentration in feed, mole %	....	1-3

Results of once-through isomerization are given in the table.

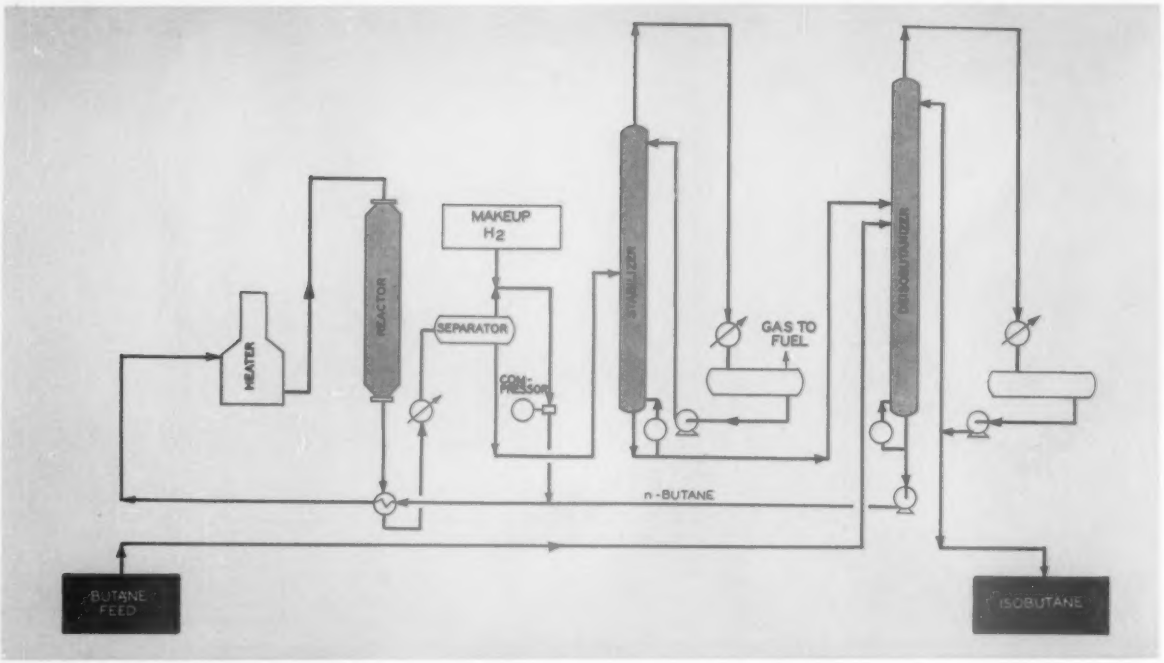
Commercial data. Five plants are in operation and one is under construction. The process is licensed by Shell Development Co.

YIELD DATA FOR BUTANE

	Volume units	
	Feed stock	Single pass isomerizate
Ethane and lighter	....	0.1
Propane	....	1.6
Isobutane	4.0	61.0
Normal butane	95.0	36.4
Isopentane and heavier	1.0	3.0
Hydrocarbons as $AlCl_3$ complex	....	<0.1

YIELD DATA FOR PENTANE

	Volume units	
	Feed stock	Single pass isomerizate
Propane and lighter	....	0.1
Butanes	....	1.7
Isopentane	6.0	70.2
Normal pentane	92.0	25.8
Heavier than normal pentane	2.0	3.0
Hydrocarbon as $AlCl_3$ complex	...	<0.1



Butamer

THE BUTAMER process is an economical method for the isomerization of normal butane to isobutane at a low ratio of hydrogen to charge.

A stable, long-lived, and noncorrosive solid catalyst containing platinum is employed. The catalyst efficiently promotes the reaction at mild processing conditions and at relatively low temperatures, thus taking advantage of the favorable low-temperature equilibrium.

The process may be operated either once-through or on a recycle scheme. The once-through product contains approximately the equilibrium concentration of isobutane. The product from recycling operation is high-purity isobutane. When yields from recycle operation are computed volumetrically, the ultimate yield exceeds 100%

Because of the low molecular weight of the charge stock, the tendency to form carbon on the catalyst is considerably lower than when reforming straightrun gasolines and naphthas. A lower hydrogen-to-charge ratio is used. Since catalyst activity is high, the process can be operated at economical liquid hourly space velocities. This provides for a reasonable catalyst inventory.

Process feed. The flow diagram illustrates a typical unit charging a feed of mixed butanes and employing reformer hydrogen as the hydrogen source.

The feed enters a deisobutanizer, the function of which is not only to prepare pure normal butane feed for the reactor section, but also to deisobutanize the stabilized reactor product. Bottoms product of the deisobutanizer (normal butane) is mixed with the required hydrogen, brought to reaction temperature and charged to the reactor. There it contacts a fixed bed of catalyst.

The reactor product is cooled, hydrogen and light gases separated for recycle, and the liquid charged to a stabilizer. The stabilizer bottoms product is then deisobutanized.

Overhead vapors from the stabilizer are small in amount and consist of hydrogen together with minor amounts of methane, ethane, and propane. The formation of these hydrocarbons is responsible for the small chemical consumption of hydrogen in the process. The hydrogen which appears in the stabilizer overhead represents "solution loss."

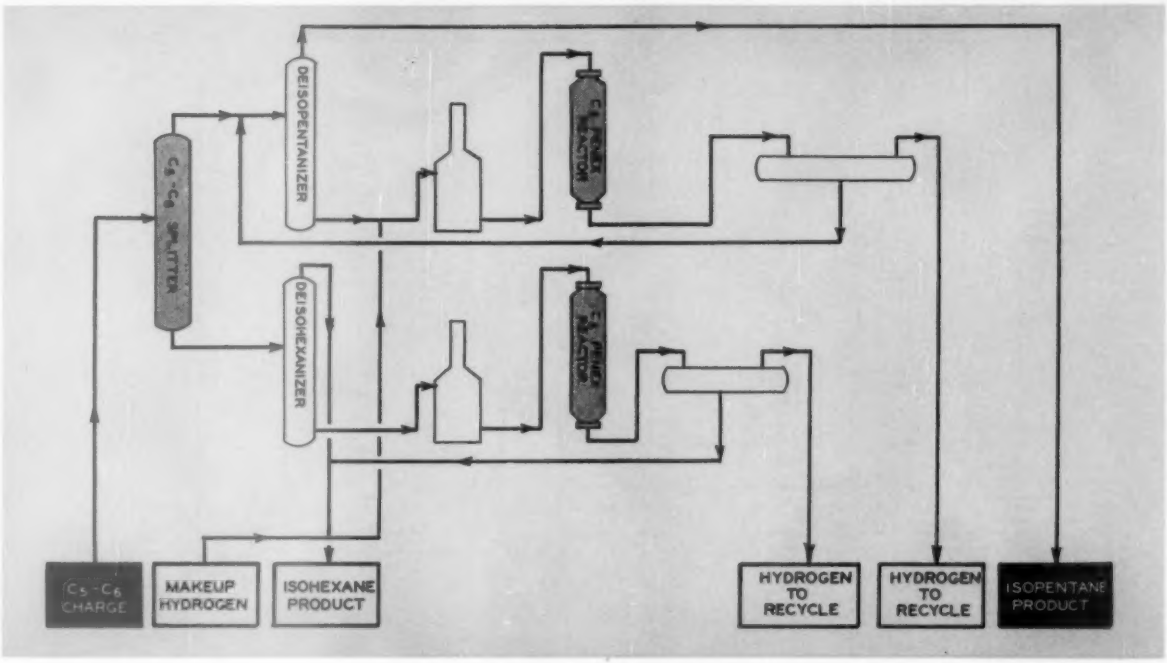
Process economics. In the table below, operating costs are given for a plant designed to produce 2,000 bbl. per stream day of isobutane product. Approximately one-third of the $1,300,000 total investment is the erected cost of the deisobutanizer and its auxiliaries.

Recognize, however, that usually a Butamer unit will be operated in conjunction with an alkylation unit. Thus, in new construction, the deisobutanizer may be designed as a single column to meet the requirements of both the Butamer and alkylation process units.

Commercial data. Two units are presently in operation and others are under construction. Design capacities range from 1,500 to 5,500 bbl. per stream day of product. The process was developed and is licensed by Universal Oil Products Co.

OPERATING COSTS, 2,000 B.P.S.D. ISOBUTANE PRODUCT

	Cents per gal. isobutane
Labor	0.25
Utilities	0.75
Catalyst	0.15
Maintenance, taxes, etc	0.20
	1.35



Penex isomerization

PENEX IS a commercial process for isomerizing the pentane and hexane fractions from refinery naphthas and natural gasolines, using a platinum-containing catalyst in the presence of hydrogen.

Maximum yields are obtained by separately processing close-cut fractions, rather than mixtures. In small-capacity installations, however, it may be found more desirable to isomerize the mixtures because of the smaller capital investment involved.

Process flow. The flow scheme indicated assumes a mixed C_5-C_6 charge and individual isomerization of pentanes and hexanes. It is split into two cuts, each of which is further split to remove the lower-boiling high-octane isomers from the respective reactor charges. The selected fraction is mixed with hydrogen, heated, and admitted to the appropriate reactor.

Over-all heat of reaction is low and operating conditions are mild. Hydrogen is not consumed in significant quantities and generally is recycled. Hydrogen makeup normally is derived from the net hydrogen-rich gas production of a UOP Platforming unit.

Types of operation. Penex processing may be either once-through or employ recycling of unconverted hydrocarbons in any degree of flexibility desired for the individual installation. Both features are illustrated in the flow diagram.

Catalyst regeneration and corrosion-resistant construction are not required. These features not only reduce the original capital investment but greatly simplify the operation while minimizing maintenance requirements.

Yield data. Several commercial units are being operated to isomerize C_5 fractions, and one unit to isomerize hexanes. Capacities range from 250 to 16,000 bbl. per stream day. Representative yields and economics when charging a mixed C_5-C_6 feed are shown in the tables.

Limited space prevents the presentation of specific economic data due to the wide differences which may exist in building and operating individual units, since the possible process applications are so extremely varied. Qualitatively speaking, therefore, the Penex process is economically attractive because the high yields will provide a sizable increase in the leaded octane quality of the refinery pool gasoline. The Penex process is licensed by Universal Oil Products Co.

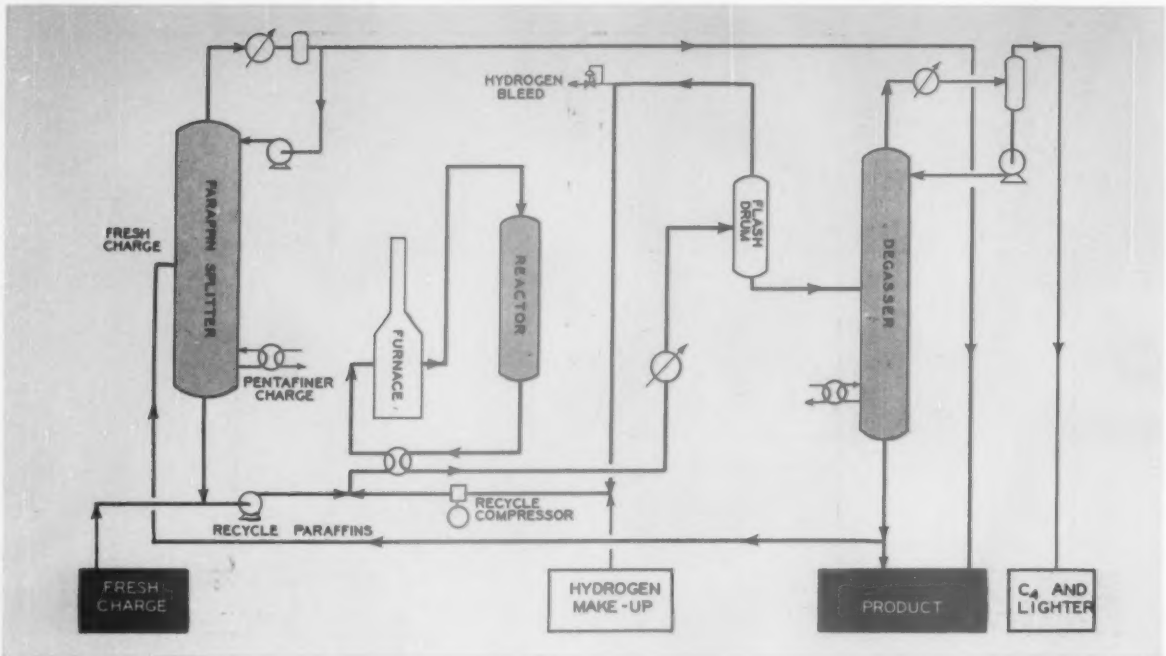
TABLE 1—YIELDS FROM C_5-C_6 FEEDSTOCKS

	C_5-C_6 feed	Penex products: C_5 product	Penex products: C_6 product
Yields, vol. % reactor charge	...	99.0	98.2
RON, clear	65.4	91.0	74.8
RON + 3 ml. TEL per gal.	88.6	103.0	93.0

TABLE 2—ECONOMIC DATA ON PENEX

	C_5-C_6 splitter	C_5 Penex (total recycle)	C_6 Penex (partial recycle)
Fresh feed, b.p.s.d.	6,464*	2,580	3,800
Isomerized product, b.p.s.d.	...	2,552	3,732
Operating cost, per bbl.:			
Labor and supervision	...	7.4	3.3
Utilities	...	17.5	11.3
Maintenance, taxes and insurance	...	6.2	4.8
Catalyst replacement	...	2.0	2.0
Total	...	33.1	21.4

*Includes 84 b.p.s.d. withdrawn as dragstream.



Pentafining

PENTAFINING is a catalytic process developed by Atlantic Refining Co. to isomerize normal pentane and normal hexane. The process may be applied economically to the C_5-C_6 fraction of straightrun naphtha, natural gasoline, and catalytic reformates.

Good octane improvement is realized with minor losses to hydrocarbons lighter or heavier than the charge. The process is attractive for the production of high-octane blending stocks for both aviation and motor gasolines.

Process flow. Application of Pentafining to a mixture of C_5 or C_6 paraffins is shown in the flow diagram. If the normal paraffin content is high enough, the feed is charged directly to the reaction section. In many cases, however, a splitter tower is justified to concentrate normal paraffins in the reactor charge.

Effluent from the reactor is heat exchanged, cooled, and then run to a flash drum. Liquid from the flash drum passes to a degasser tower where butane and lighter hydrocarbons are removed. Economics again determine whether the degasser product is recycled to the splitter, for further octane improvement, or is sent directly to gasoline blending.

Low-boiling mercaptans and hydrogen sulfide in the feed may be removed by a caustic wash, or by a conventional amine scrubber on the recycle gas.

The catalyst used in Pentafining is a combination of platinum and silica-alumina, specifically designed to promote isomerization with low losses to fuel gas. Use of silica-alumina gives the catalyst complete tolerance for water and nitrogen compounds, and requires no halide promoters which contribute to unit corrosion. The catalyst is easily regenerable in place.

Yield data. The selective nature of the catalyst at reactor temperatures of 750°-950° F. and pressures of 300-700 psig. makes it possible to operate at close to chemical equilibrum with insignificant losses to hydrocracking. Ultimate conversions of close to 100% are possible by recycling and fractionating out the isoparaffins produced.

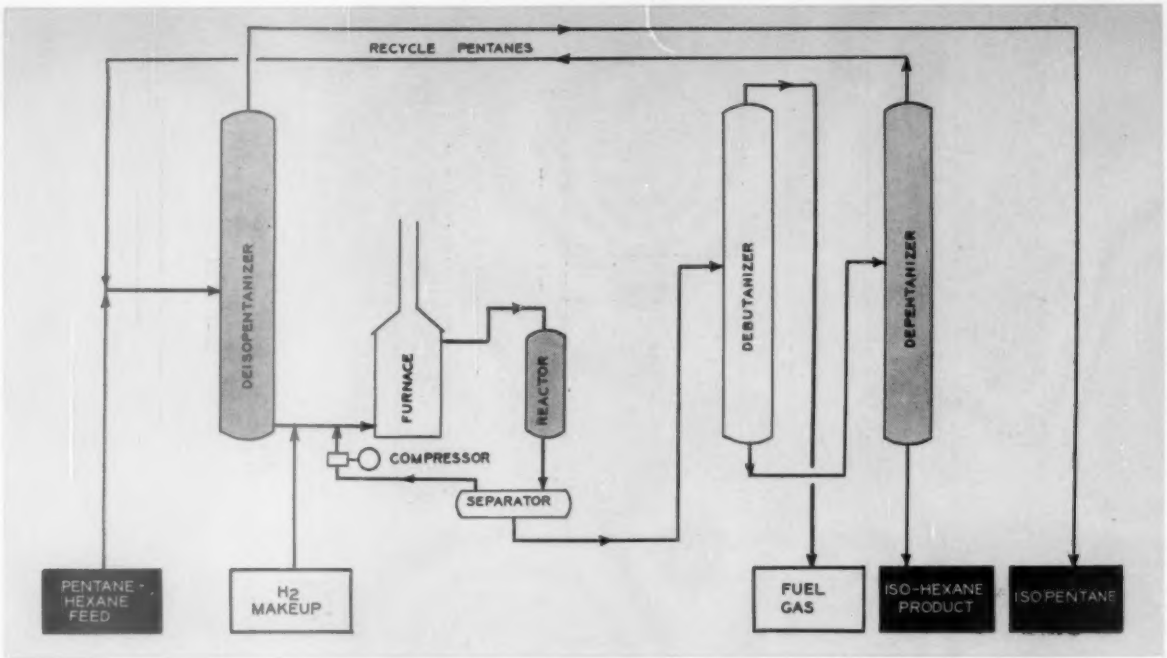
Yield and octane improvement resulting from the isomerization of hexanes from typical Middle East crude are given in the table. In general, the ultimate yields of 95% isopentane from any mixture of pentanes charged will be 99-100% (vol.). Octane improvement will be up to 29 research number clear, or up to 20 at 3 ml. TEL.

Since Pentafiner units have only a single reactor, they are, in effect, simplified reformers. Therefore they cost but a fraction of a reformer of similar capacity.

Investment costs. Low hydrogen recycle and catalyst requirements, plus the basic simplicity of the process, result in an investment cost of $100-$200 per barrel of charge, depending upon size. Operating costs are in the range of 10-15 cents per barrel.

YIELDS AND OCTANE IMPROVEMENT FROM C_6 ISOMERIZATION

	Middle East
C_6 charge:	
Research octane, clear	59.8
Research octane, 3 cc.	85.6
R.v.p.	5.4
C_6 product:	
Research octane, clear	73.3
Research octane, 3 cc.	93.3
R.v.p.	5.9
Volume per cent of charge	96.5



Iso-Kel process

ISO-KEL is a highly selective process for isomerizing low-octane pentanes and hexanes to high-octane isoparaffinic blending stock.

A precious-metal catalyst of high selectivity, developed by Kellogg, makes it possible to charge pentanes and hexanes from crude oil, natural gasoline, condensates; or those produced by coking, cracking, or reforming. Volumetric liquid product yields are above 98%.

Features. Pentanes and hexanes can be processed together in a single reactor without loss of product selectivity. The catalyst is operated under hydrogen pressure to minimize coke deposits and obtain long catalyst life. Extraneous hydrogen is fed to the system, but hydrogen consumption is low. Under normal operating conditions catalyst regeneration is not required. However, the Iso-Kel catalyst can be regenerated in place.

TYPICAL YIELDS AND PRODUCT PROPERTIES

	Kuwait*		Mid-Continent*		Natural gasoline†	
	Feed	Product	Feed	Product	Feed	Product
Total C_5-C_6, vol. %	100.0	98.6	100.0	98.3	100.0	99.2
Octane CFRR—						
clear	64.1	79.0	63.0	78.0	73.0	85.7
+ 3 cc. TEL	88.2	96.0	86.5	95.0	93.4	99.6
Isopentane Fraction:						
Vol. % of total C_5-C_6	45.0	45.0	34.5	34.5	58.5	58.5
Octane CFRR—						
Clear	74.4	92.0	72.9	92.0	79.2	92.0
+ 3 cc. TEL	95.8	105.6	94.5	105.6	98.0	105.6
Isohexane Fraction:						
Vol. % of total C_5-C_6	55.0	53.6	65.5	63.8	41.5	40.7
Octane CFRR—						
clear	55.9	68.0	57.7	70.5	64.0	76.4
+ 3 cc. TEL	82.0	89.0	82.3	90.0	86.8	93.5

*Recycle of n-pentane and once-through on hexanes.
†Deisohexanizing facilities included.

Process flow. Depending upon feed-stock quality and degree of upgrading desired, the process scheme can be varied to allow for prefractionation of isomers in the feed, and recycle of unconverted material.

In the simplified flow diagram shown, pentanes are processed on a recycle basis and hexanes once-through. However, by addition of a deisohexanizer and dehexanizer, the hexanes can be fractionated and recycled to produce a higher-quality-isohexane product.

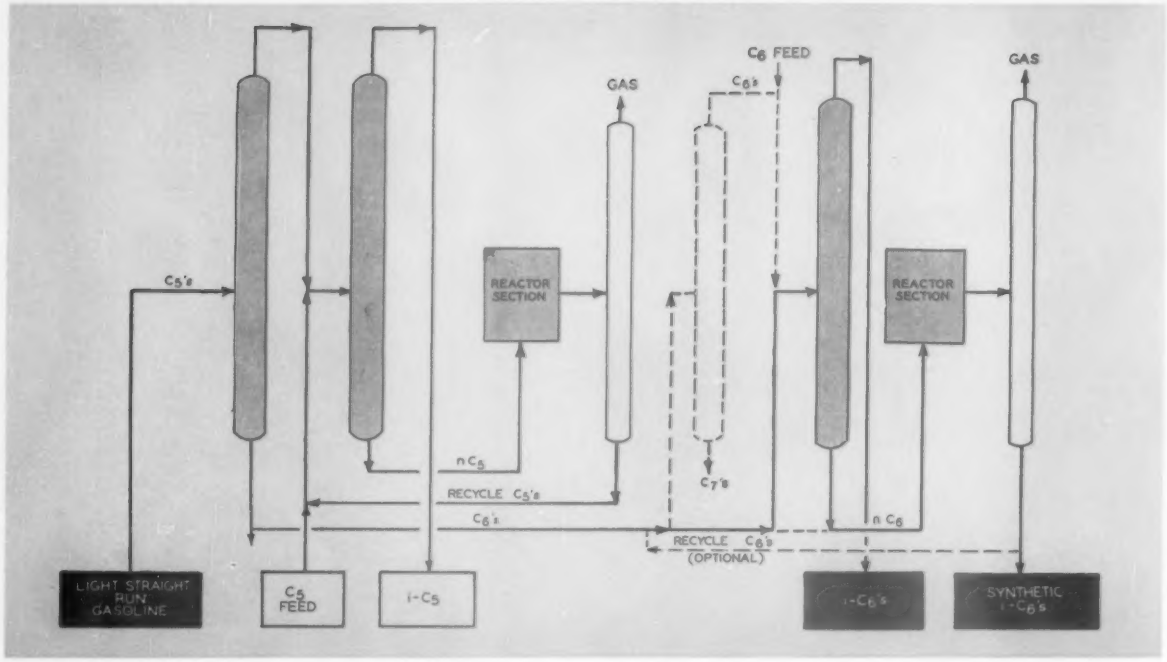
The combination feed-preparation and product-separation section consists of three fractionating towers. In the deisopentanizer, recycle pentane and the pentane-hexane feed are fractionated to separate an isopentane product of 95% or higher purity. Bottoms from this column are charged to the reaction section.

Following the reaction system, the liquid is fed to a debutanizer to remove a small quantity of absorbed gas. Bottom product from the debutanizer is charged to the depentanizer. There the total pentane product is removed overhead and recycled to the deisopentanizer. The isohexane product is removed as depentanizer bottoms.

Operating conditions. Reactor temperatures are in the range of 650°-850° F. Pressures range from 350 to 600 psig. Other process variables are recycle-gas rate and space velocity.

Yield data. When charging pentanes only, the yield of isopentane fraction will be about 99 vol. %. The combined isopentane and isohexane fractions have essentially the same octane number by motor and research methods.

Iso-Kel was developed by M. W. Kellogg Co. and is licensed by that firm.



Isomerate process

THE ISOMERATE process of Pure Oil Co. upgrades low-octane feed stocks in the presence of hydrogen and a catalyst. Any conventional light-hydrocarbon stocks are potential feeds.

Heart of the process is the Isomerate catalyst, a dual-functional type containing a small amount of an active hydrogenation metal in a high surface support. Using the rugged, high-activity catalyst, paraffin isomerization selectively approaches thermodynamic equilibrium at temperatures far below those used in catalytic reforming processes.

Description. The flow diagram shows several general schemes.

First, debutanized light straightrun gasoline is depentanized. The pentane fraction then is split to produce an isopentane product and n-pentane reactor feed. Degree of fractionation determines the product octane number, since the n-pentane is recycled to extinction.

The hexane fraction may be used directly in gasoline blending, or it may be isomerized by one of two methods shown. In one case the hexane fractions, high in n-hexane, can be improved by direct single-pass isomerization without fractionation. For further octane improvement, however, it is generally preferable to fractionate the isohexanes to product and isomerize the n-hexane in a single-pass operation.

Operating conditions. Reactor pressures are below 750 psi. and temperatures below 800° F. The rugged isomerization catalyst can be regenerated in place at infrequent intervals.

Product quality. Research octane number of the isopentane product approaches 108.6 (with 3 ml. of TEL), depending upon the degree of fractionation. Most light straightrun naphthas produce an Isomerate having an F-1 octane of 94 to 100-plus at the 3-ml.-TEL level, depending upon feed composition, extent of recycling, and efficiency of fractionation.

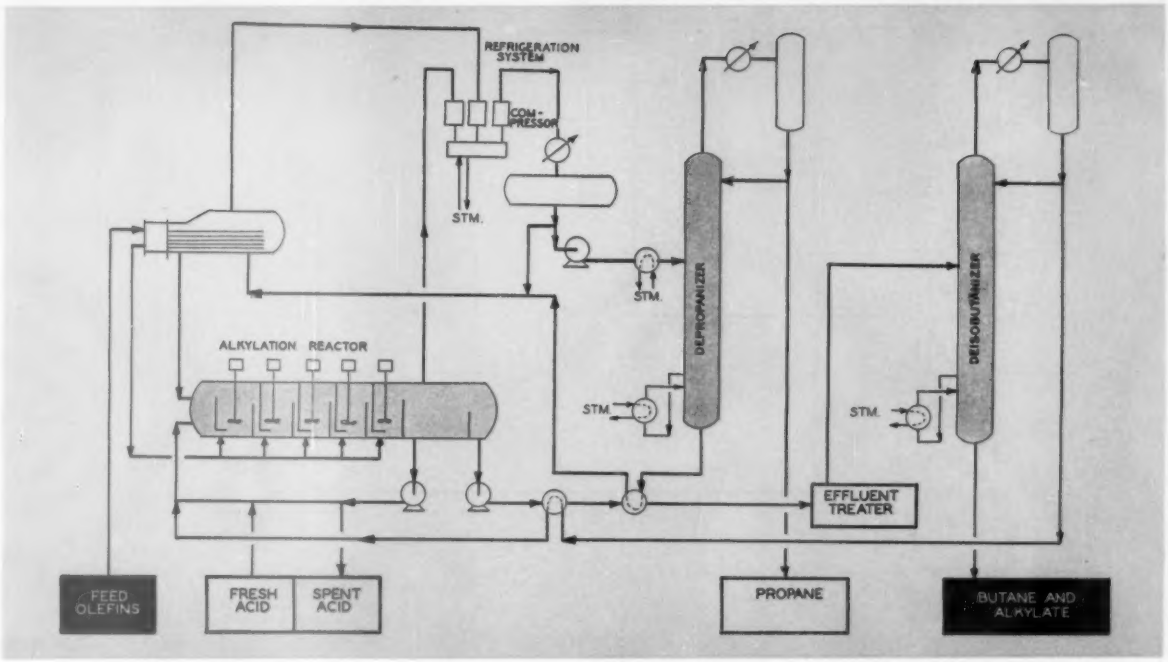
Refinery applications. Installation capacities are designed for a total C_5-C_6 feed stock of about 10,000 bbl. per calendar day.

Case 1 considers isomerization of the pentane fraction only. In Case 2 the hexanes are split and the n-hexane is isomerized on a once-through basis. In Case 3, n-pentane is isomerized to extinction and n-hexane is processed on a once-through basis. Cost of a C_5-C_6 feed fractionator is included in this case.

COMPARATIVE PROCESS INVESTMENT AND OPERATING COSTS

Case	1	2	3
Product, B.c.d.	4,000	6,000	10,000
Research octane number (with 3 ml. TEL):			
Feed, total	95.9	86.0	90.0
Feed, reactor	....	81.6	....
Product, total	105	92.8	97.7
Product, natural isomer	....	94.4	....
Product, synthetic isomer	....	91.9	....
Investment, in $1,000	$1,820	$1,250	$3,715
Operating costs, direct*			
$/C.D.	1,859	1,576	4,084
Cents per gallon product	1.1	0.6	1.0
Cents per RON-B (+ 3 ml. TEL)	5.4	4.2	5.6
For an assumed 3-year payout, before taxes, increase in value of product is:†			
Cents per gallon product	2.2	1.1	1.9
Cents per RON-B (+ 3 ml. TEL)	10.7	7.5	10.9

*Utility costs are:
Fuel $2.10/B (FOE)
Steam $0.60/1,000 lb.
Water $0.02/1,000 gal.
Electricity $0.01/kw.-hr.
†Also includes local taxes and insurance, and overhead.



Cascade sulfuric acid alkylation

THE CASCADE PROCESS, which uses autorefrigeration for reaction-heat removal, produces high-octane gasoline through improved reaction selectivity.

Side reactions, which lead to lower-quality product and catalyst degradation, have been minimized by maintaining high isobutane and low olefin concentrations within each reaction zone. Propylene, butylenes, and amylenes are effectively processed either separately or in mixtures.

Olefin concentration is controlled by splitting the olefin feed into a number of parallel streams, each of which is fed to a separate reaction zone containing its own mixer.

Description. Low temperature is maintained by autorefrigeration, which consists of allowing the heat of reaction to vaporize some of the hydrocarbon in each zone. This technique is more efficient than indirect heat exchange or pressure reduction. Hydrocarbon vapor so liberated is compressed and condensed after which the condensed refrigerant is depropanized and mixed with recycle isobutane and acid catalyst.

This mixture then flows in series through the reaction compartments. Each receives the total recycle and all of the refrigerant isobutane which will vaporize in later zones. This arrangement results in an average isobutane concentration considerably greater than that obtained if the olefin feed and isobutane-recycle streams are mixed before entering the reactor.

Reactor effluent, which contains reaction products, recycle isobutane, and inert feed components, is separated from the acid catalyst in the reactor settling zone. Subsequent treatment removes entrained acidic materials, and the effluent is then fractionated to separate isobutane recycle from butane and alkylate.

During recent years improvements in processing techniques have cut investment and operating costs markedly. Conversely, with these same techniques, many older units are exceeding their original design by large margins. Together with this throughput improvement, fouling, corrosion, and acid consumption have also been reduced.

Yield and cost data. Typical recent results obtained in Kellogg Cascade reactors are given in Table 1. Typical investment requirements and utility consumptions are given in Table 2.

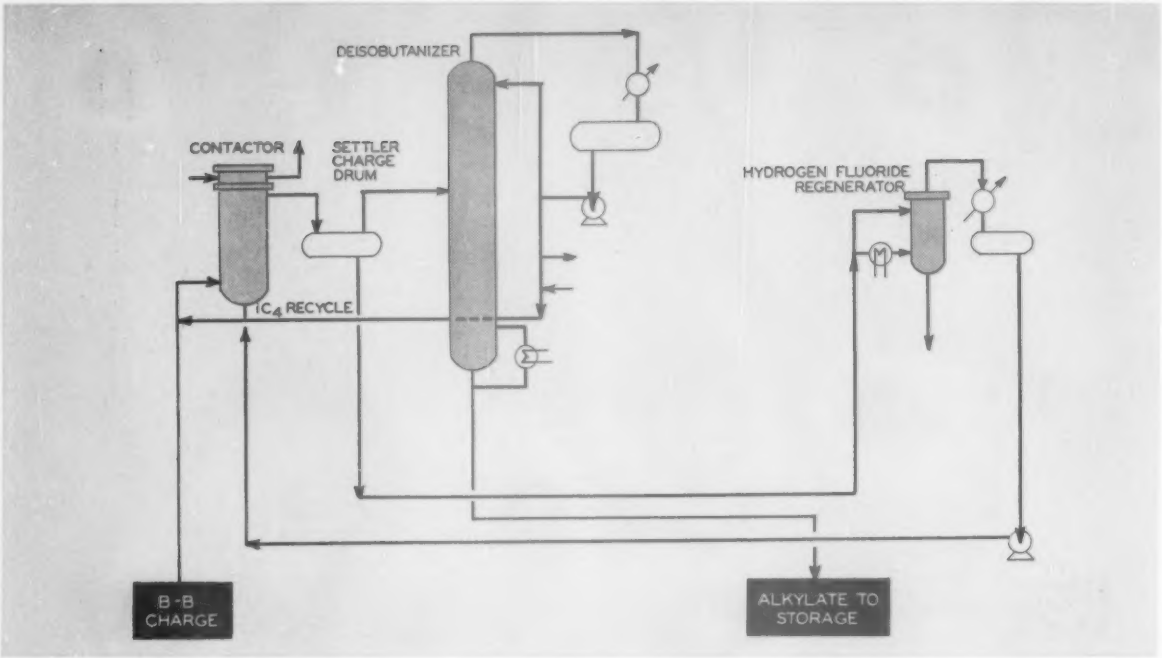
Commercial data. Many Cascade alkylation units have been designed and/or built by M. W. Kellogg Co., developer and licensor of the process.

TABLE 1—TYPICAL ALKYLATION YIELD DATA

Olefin feed	Butylenes	45% C_3—/55% C_4—
Yield, bbl. alkylate per bbl. olefin	1.72	1.74
Isobutane consumption, bbl. per bbl. olefin	1.11	1.18
Acid consumption, lb. per gal. alkylate	0.24	0.34
Alkylate octane numbers:		
F-1, clear	97.3	95.5
+ 3.0 ml. TEL	112.0	108.2
F-2, clear	93.5	91.5
+ 3.0 ml. TEL	106.8	104.8

TABLE 2—INVESTMENT REQUIREMENTS AND UTILITY CONSUMPTIONS

Capacity	1,000-5,000 b.p.s.d. of total alkylate
Investment	$550-$950 per barrel of alkylate
Steam	22,000 lb. per hour per 1,000 b.p.s.d. of alkylate
Cooling water	2,000 g.p.m. per 1,000 b.p.s.d. of alkylate
Power	200 kw. per 1,000 b.p.s.d. of alkylate



HF alkylation (UOP)

HF ALKYLATION is a catalytic method of reacting isobutane with propylene, butylenes, amylenes, higher-boiling olefins or mixtures of olefins from thermal or catalytic cracking.

The product formed is a highly-branched paraffinic material of excellent antiknock properties and tetraethyl lead susceptibility for use as a blending component in aviation gasoline or motor fuel. Butylenes, or butylenes-plus-propylene are the most common olefin-charging stocks.

Applications. Hydrogen fluoride (HF) alkylation is especially applicable in a refinery where additional isobutane charge and low-boiling materials required for gasoline vapor pressure can be obtained at low cost from sources other than cracking. This permits use of all the low-boiling olefins as charging stock for the production of alkylate. HF consumption is no higher for propylene or amylenes than for the butylenes.

The process is excellent for making 100-plus-octane blending components for premium motor fuels and aviation gasolines.

Process flow. The flow diagram is arranged for the production of motor-fuel alkylate. In aviation-gasoline production a rerun column, bauxite towers, and a debutanizer, also would be required.

Marked improvements have been made to simplify design and thereby lower capital and operating costs, both in the aviation and motor-gasoline alkylation units. A lower catalyst inventory is required than formerly, and plant arrangement and control have been simplified.

The contactor has been reduced in size and HF-circulation pumps have been eliminated. The regenerator has been simplified with provisions for improving the purity of regenerated HF. Fractionation-section changes have been made to reduce utility requirements.

Products. Isobutane requirements, yields, and product qualities are shown in Table 1. Analytical data and antiknock rating interrelationship for a rerun butylene alkylate are shown in Table 2.

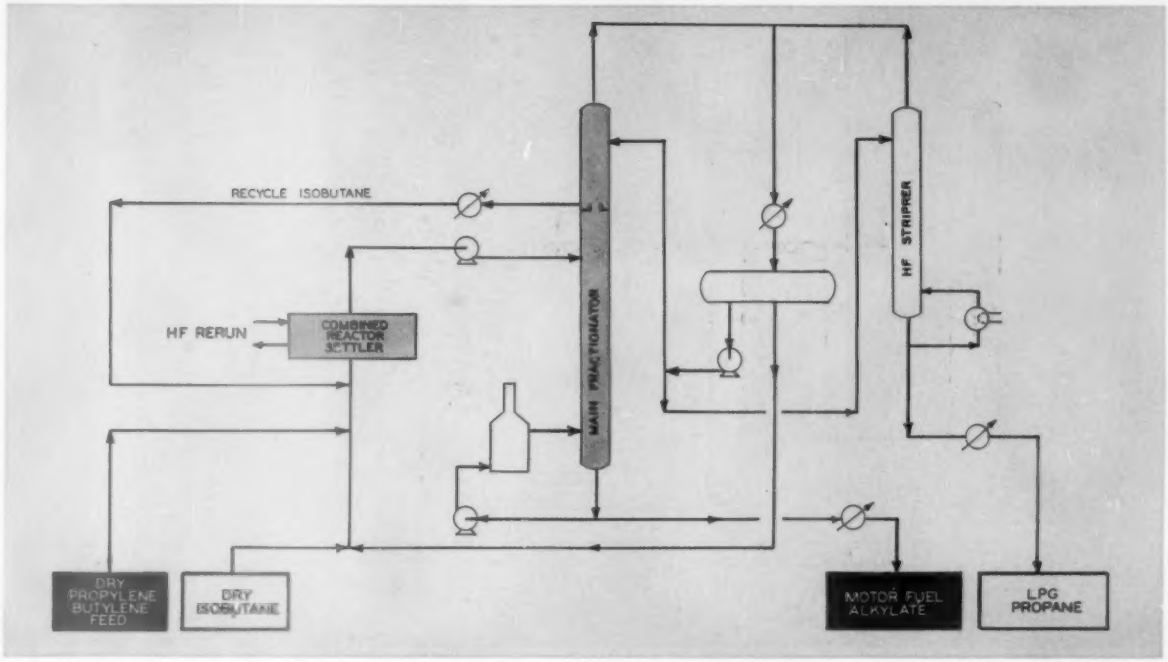
Optimum processing arrangement and conditions must be determined for each installation. Installation costs for motor alkylate run as low as $700 to $1,000 per barrel for units down to 500 bbl. per stream day of 3.5-lb. R.v.p. product. This process is licensed by Universal Oil Products Co.

TABLE 2—ALKYLATE PROPERTIES

Gravity, °API	70.7
Reid vapor pressure, psi.	3.5
Isopentane content, vol. %	4.3
Rerun alkylate, vol. % of total alkylate	94.7
Engler distillation, °F.:	
I.b.p.	148
10%	197
50%	218
90%	226
End point	275
Antiknock ratings with 4.6 ml. TEL/gal.:	
F-3, iso C_8 + ml. TEL	1.4
F-3, performance number	131.6
F-4, iso C_8 + ml. TEL	3.64
F-4, performance number	150.6

TABLE 1—YIELDS AND PRODUCT QUALITIES

	Vol./Vol. Olefin		Research Oct. No.		Motor Oct. No.	
	Isobutane	Alkylate	Clear	+ 3 ml. TEL	Clear	+ 3 ml. TEL
Butylenes	1.16	1.75	96+	iC_8 + 0.9 ml. TEL	94	iC_8 + 0.9 ml. TEL
Propylene	1.33	1.77	93	iC_8 + 0.3 ml. TEL	91	iC_8 + 0.35 ml. TEL



Perco HF alkylation

PERCO HYDROFLUORIC (HF) alkylation converts propylene, butylenes, and amylenes to highest-quality motor-fuel alkylate. With the ever-increasing demand for higher octane and better quality motor fuels, alkylate continues to be in much demand as a blending component.

Process flow. The flow diagram shows essential features of the process. With minor variations this design may be used with widely different feed stocks to produce either motor fuel or aviation alkylate.

As an auxiliary to the operation, an acid rerun unit is provided. There the hydrofluoric acid catalyst is continuously purified by fractionating a small portion of the circulating acid stream. Since the acid-soluble oil production is small, disposal is no problem.

Dry liquid feed containing olefins and isobutane is charged to a combined reactor-settler of exclusive Phillips' design. Reactor temperature varies between 70° and 100° F., depending on the available cooling-water temperature and supply. Hydrocarbon phase produced in the settler is fed to the main fractionator. There the needed separation is accomplished to produce LPG quality propane, alkylate product ,and a recycle isobutane. Small amounts of dissolved HF are removed from the propane product by the HF stripper, a small tower.

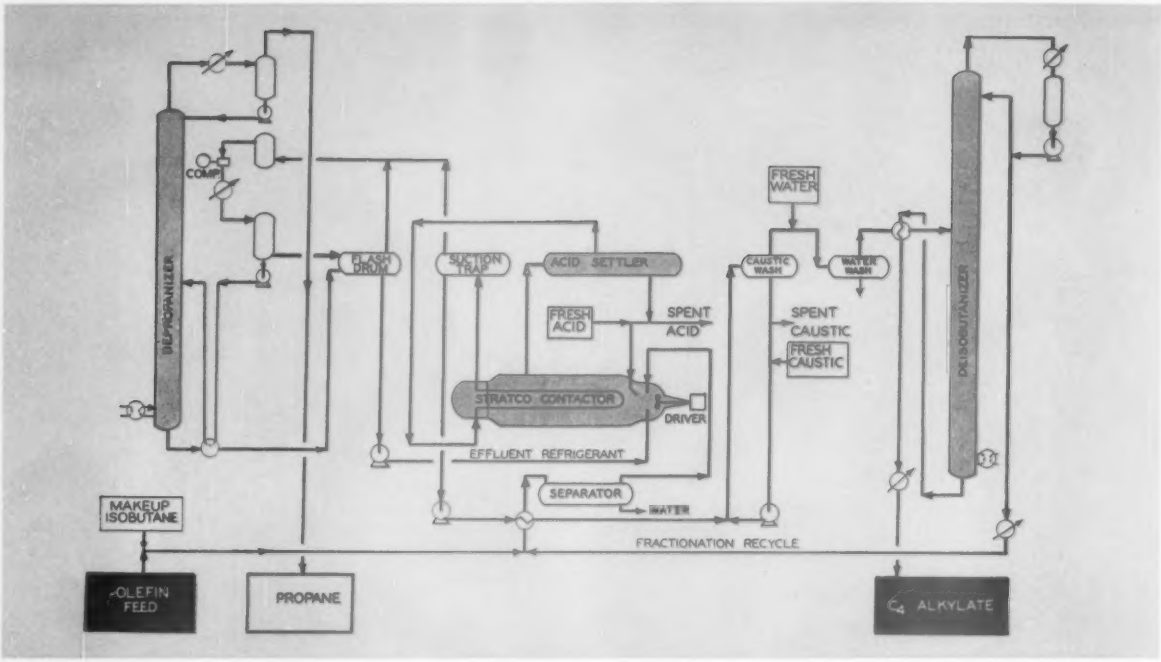
Stabilization of the alkylate product to remove normal-butane content can be accomplished by a main-fractionator vapor sidestream, if either necessary or desirable.

Yield data. Yields and inspection data on a typical operation are given in the table. The yields are based on 100 bbl. total feed, using a propylene-butylene cut from catalytic cracking. As shown, alkylate recovery was 52.2 bbl. When operating on a straight butylene feed, commercial data on one unit show that it produces debutanized alkylate with a motor octane number of 94 clear; motor octane is 108.3 with 3 cc. TEL.

The process is licensed by Phillips Petroleum Co., Bartlesville, Okla.

TYPICAL YIELD AND QUALITY DATA

Charge, (bbl.):	
Propane	15.3
Propylene	9.9
Butylene	19.6
Isobutane	37.9
n-Butane	17.3
	100.0
Yields, (bbl.):	
Propane	16.7
Isobutane	1.2
n-Butane	17.3
Alkylate	52.2
	87.4
Debutanized motor-fuel alkylate:	
Gravity, °API	71.5
R.v.p., psi.	4.5
ASTM distillation, °F.	
I.b.p.	120
50% evap.	212
E.p.	355
Color, Saybolt	30
Doctor test	Negative
Corrosion, 122° F.	Negative
ASTM gum, mg./100 ml.	0.4
Research octane number, clear	94.0
+ 3 cc. TEL/gal.	106
Motor octane number, clear	91.8
+ 3 cc. TEL/gal.	107
Operating service factor: 98%	



Effluent refrigeration alkylation

EFFLUENT REFRIGERATION applied to the sulfuric acid alkylation process results in low capital investment, low operating costs, high yields, high-quality alkylate, and low acid consumption.

Effluent refrigeration is essentially a means of economically getting a very high isobutane concentration in the reaction mixture with little conventional fractionation. The hydrocarbon portion of the reaction mixture becomes the refrigerant used in the cooling elements of the reactor; hence the term effluent refrigeration.

It is economical to operate with an isobutane-to-olefin ration of nine or higher. Or, an isobutane concentration can be used which is as high as 75% of the hydrocarbon portion of the reaction mixture. These figures can not usually be justified when conventional fractionation is used.

When processing a mixed propylene-butylene feed, the total debutanized alkylate has an F-1 octane ranging from 92 to 96 clear. F-1 octane ranges from 103 to 107 with 3 cc. TEL. When processing straight butylenes, commercial data show that units are producing debutanized alkylates which have as high as 99 F-1 octane clear and 115 with 3 cc. TEL.

Process flow. The feed streams along with a recycle H_2SO_4 stream are charged to a contactor. Here the liquid contents are circulated at high velocities, so that a large amount of interfacial area is exposed between the reacting hydrocarbons and the acid catalyst. Temperature between any two points in the reaction zone does not vary more than 1° F.

Overhead from the deisobutanizer together with effluent refrigerant is recycled to the reactor. Normally, about 60% of isobutane recycle comes from the effluent refrigeration step; only 40% comes from the deisobutanizer.

Reactor system. Contactors are of the new horizontal design using a U-tube heat exchanger. Very efficient heat transfer is obtained, resulting in close temperature control and a small cooling-surface requirement. Reactors of this design cost less to install and to maintain.

Catalyst consumption. This depends on a number of factors such as composition of the feed stock; amount of impurities in the feed stock, such as water, butadiene, and sulfur compounds; and operating conditions.

Under favorable conditions consumption of sulfuric acid may be as low as ¼ lb. of acid per gallon alkylate for butylene alkylation. For propylene-butylene feed, acid consumption is 0.4 to 0.5 lb. per gallon of alkylate.

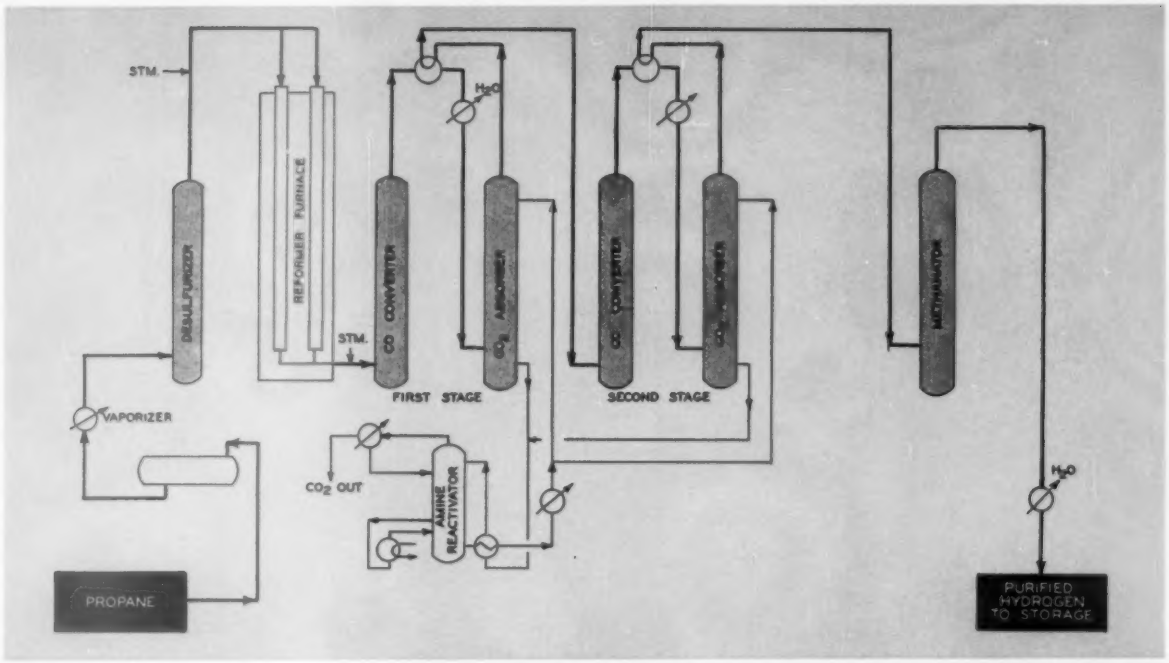
For either butylene alkylates or mixed-feed operation, plants are normally designed to produce alkylate with an end point of less than 400° F. Therefore, the entire product may be used in motor fuel.

Twenty-nine of these units are in operation or under construction. Information about the process may be obtained from Stratford Engineering Corp., Kansas City, Mo.

TABLE 1—TYPICAL QUALITY AND ACID-CONSUMPTION DATA

Plant—	A	B
Olefin composition		
% propylene	0	60
% butylene	100	40
Properties of total alkylate (not rerun)		
50%, °F.	222	210
90%, °F.	242	247
E.p., °F.	340	346
R.v.p.	8.7	6.0
F-1 clear octane	98.4	93.4
F-1 + 3 cc TEL	112.1	106.7
Acid consumption, lb. per gal.	0.40	*0.41

*3-month average.



Hydrogen (Girdler)

IN REFINERIES without sufficient reformer hydrogen, the Girdler Corp. system can be used to produce hydrogen with extremely low carbon-oxides content for carrying out hydrodesulfurization, hydro-cracking, and other product-upgrading operations.

In general, these plants use the steam-hydrocarbon process, operated at near-atmospheric pressure or at high pressures up to 10 or 11 atm. One or two shift-converter and carbon dioxide-removal steps are used, depending upon the degree of hydrogen purity desired. These are usually followed by a methanation stage.

Feed stocks used in generating hydrogen for refinery use include natural gas, refinery gas, propane, and butane. In typical applications where two-stage conversion is used, hydrogen of 98% purity and higher is produced.

Process flow. The flow diagram shown is based on use of propane for feed stock. Propane or other hydrocarbon gas or oil may be used as fuel for the reformer furnace. The feed stock must be desulfurized before entering the reformer.

In the reforming furnace propane vapors and steam are passed over a nickel catalyst, resulting in an effluent containing about 75-80% hydrogen, 10% carbon dioxide, and 0.2-5.0% residual methane. Hot gases are cooled by injecting condensate and then run to the first-stage shift converter. There more hydrogen is produced as a result of the steam-carbon monoxide reaction.

After most of the CO_2 is removed in an absorber (amine or hot potassium carbonate), the gases are again mixed with steam and run to the second-stage converter. Further scrubbing is again carried out. If needed, remaining traces of CO and CO_2 are removed in the methanator, where they are converted to methane by reacting with hydrogen over a nickel catalyst.

Hydrocarbon impurities in the product hydrogen usually will not harm those processes where the hydrogen will ultimately be used. Therefore these impurities are allowed to remain in the effluent gas.

If purity requirements are not strict, the hydrogen furnace can be operated at higher space velocities and lower temperatures than would otherwise be possible.

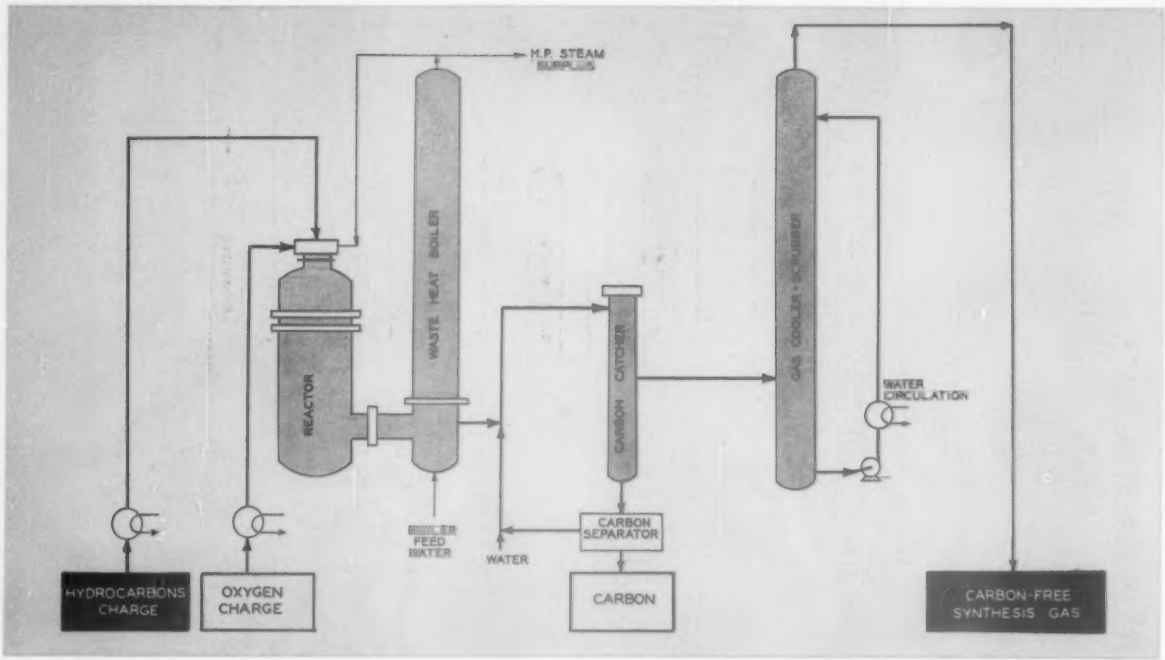
Utility requirements. Typical raw material and utility requirements per 1,000 cu. ft. of high-purity hydrogen are given in the table. Data in column 1 are based on a low-pressure operation with two stages of CO conversion and CO_2 removal followed by methanation.

Data in column 2 are based on high-pressure operation with one stage of purification and includes heat recovery from the process gas and furnace flue gas.

Commercial data. More than 70 Girdler hydrogen plants have been built, including several used for desulfurizing refined-product streams. Largest oil industry plant has a capacity of more than 30,000 M.c.f. daily.

TYPICAL UTILITY REQUIREMENTS PER 1,000 CU. FT. OF HIGH-PURITY HYDROGEN

	Low pressure without heat recovery (propane)	High pressure with heat recovery (natural gas)
Feed stock, gal. or cu. ft.	2.75	260
Fuel, M.B.t.u.	225	215
Steam at 70 psig., lb.	335	0
Cooling water, 30° F. rise, gal.	1,450	400
Power, excl. of lighting, kwh.	1.0	1.0
Est. cost of replacement catalysts and chemicals, cents	1.0	0.6
Boiler feed water, gal.		4.0



Gasification process (Shell)

THE SHELL gasification process, by means of controlled partial combustion in a special reactor, can be used to produce synthesis or fuel gas at a range of pressures up to 600 psig. from any hydrocarbon—methane to residual oil.

Yields of crude hydrogen range from about 60%, using a natural-gas charge, to approximately 46 vol. % when a heavy fuel oil is used.

A feature of the process is the high reaction temperature, approximately 2,000° to 2,750° F. Exothermic heat of reaction is used in a waste-heat boiler to produce steam of any desired pressure.

Description. In the basic form of the Shell process, oil (or gas), and oxidant (oxygen or air) are separately preheated and charged to the reactor. Before entering the reaction zone, they are intimately mixed in a combustion chamber.

In the reaction zone, heat from combustion of part of the oil pyrolyzes the remaining oil into gas and some carbon. Reactor effluent then passes through a Shell-patented waste-heat boiler, a carbon-removal unit, and a water cooler-scrubber.

Products are the carbon-free synthesis gas and a small amount of carbon which can be recovered in a form suitable for combustion. When fuel oil is gasified with oxygen, gross steam production in the waste-heat boiler amounts to about 2.3 lb. per lb. of feed.

. . . Main products are hydrogen and carbon monoxide. Small amounts of carbon dioxide and methane are also produced. If sulfur is in the feed stock, hydrogen sulfide and carbonyl sulfide (COS) are also produced.

Typical results with oxygen using natural gas, naphtha, and heavy fuel-oil feed stocks are given in the table.

Operation. The process is noncatalytic, continuous, simple to operate, and requires minimum labor and supervision.

On-stream factors of 95% have been achieved. Despite the presence of finely divided carbon in the hot gas, the waste-heat boiler is nonfouling. High heat-transfer rates are maintained.

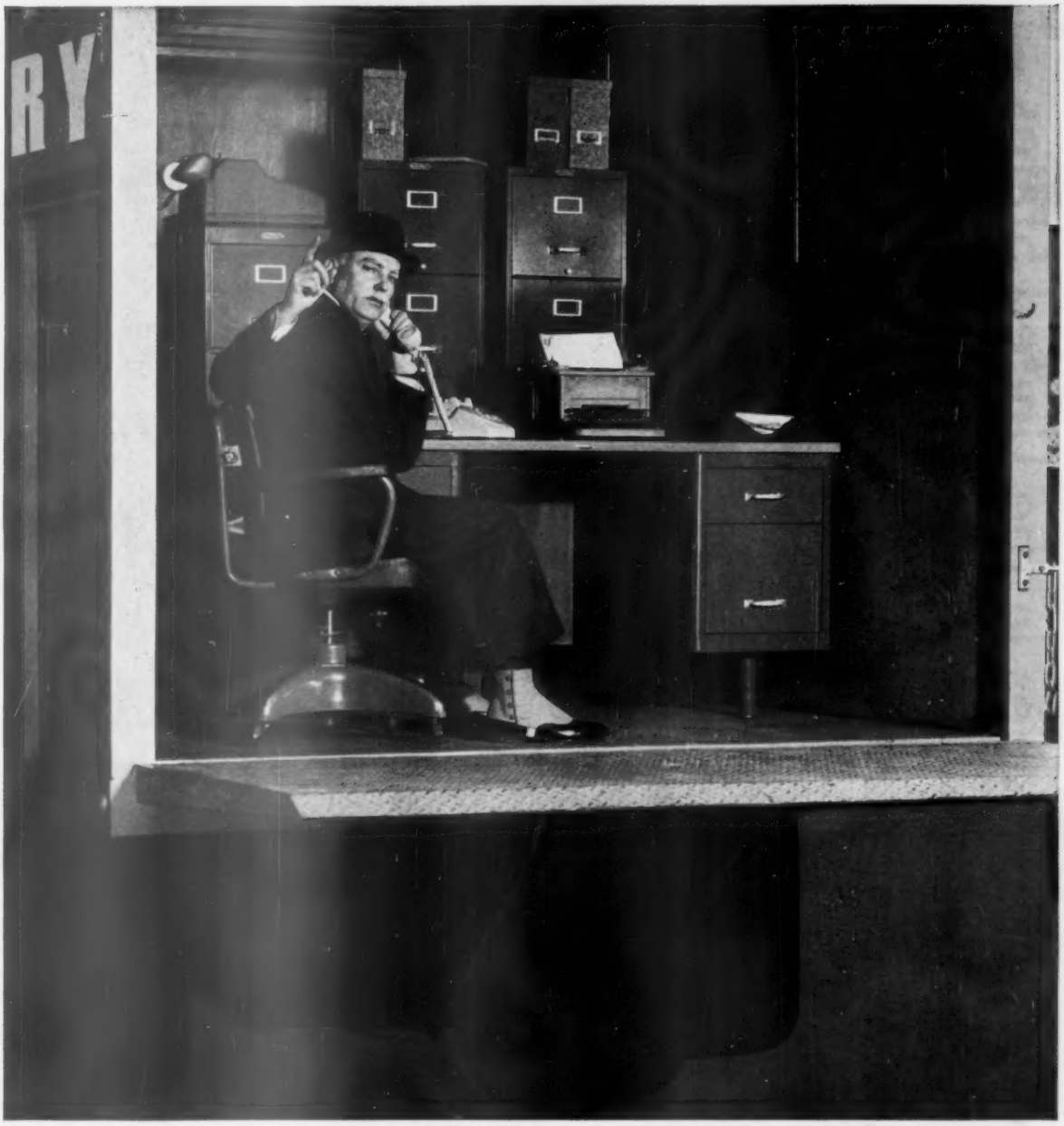
Practically the entire plant is constructed of carbon steel. Commercial-grade firebrick is used as refractory in the reactor section. Experience in existing plants has revealed no maintenance problems.

The high flexibility of the process makes it possible to change feed stocks within ½ hour. Plant throughput can be reduced to about 60% of design capacity without any effect on the equipment or on performance of the process.

Commercial data. Five plants are operating and eleven are under construction. The process is licensed by Shell Development Co.

TYPICAL SYNTHESIS GAS YIELDS
(In vol. % of crude, dry product)

Product Components	Feed stocks: Natural Gas	Naphtha	Heavy Fuel oil
H_2	60.9	51.6	46.1
CO	34.5	41.8	46.9
CO_2	2.8	4.8	4.3
CH_4	0.4	0.4	0.4
$N_2 + A$	1.4	1.4	1.4
$H_2S + COS$		70 p.p.m.	0.9



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Journal Survey of Refineries in the United States

Location and Capacities as of January 1, 1961*

State	No. Plants	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking: Fresh Feed	Catalytic Cracking: Recycle	Catalytic Reforming	Hydrogen Treating	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
Alabama	4	17,150	18,420	10,350	.....	.....	.....	.....	.....	.....	.....	.....	.....	9,100
Arkansas	6	84,675	88,485	46,300	13,000	33,400	8,200	16,740	22,500	3,500	2,300	4,700	400	9,700
California	37	1,352,960	1,419,850	600,175	535,195	375,555	145,390	282,170	310,580	51,535	5,040	23,830	3,970	70,645
Colorado	7	36,850	41,300	9,200	13,600	12,300	5,700	7,950	.....	.....	1,350	.....	.....	1,500
Delaware	2	143,500	153,685	92,644	42,000	58,000	44,000	45,000	88,000	5,000	5,100	.....	1,200	1,670
Florida	1	2,000	2,200	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,100
Georgia	2	8,800	10,250	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,920
Hawaii	1	32,000	33,685	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	615
Illinois	13	610,300	640,305	184,172	124,055	260,870	104,220	149,980	178,925	33,645	10,635	4,100	1,775	36,155
Indiana	12	502,550	529,580	186,200	109,200	176,260	38,400	115,285	96,600	15,860	4,650	9,750	1,660	23,650
Kansas	13	343,240	362,485	89,900	53,700	133,500	62,000	73,500	38,100	22,300	5,500	3,600	900	21,300
Kentucky	4	107,200	114,550	34,000	10,500	37,400	16,200	9,000	12,500	.....	4,400	.....	.....	12,000
Louisiana	13	794,457	830,400	228,615	97,700	340,550	168,800	111,950	44,920	55,700	10,770	13,360	325	13,495
Maryland	3	32,400	35,800	18,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	19,700
Massachusetts	1	50,000	55,000	13,100	.....	20,000	19,000	7,200	7,200	.....	1,800	.....	.....	10,000
Michigan	15	177,475	191,495	56,500	23,900	57,200	20,600	27,450	50,450	7,350	2,950	.....	390	12,300
Minnesota	4	70,500	73,500	10,000	12,000	29,000	12,000	7,800	18,800	1,600	1,970	.....	600	5,000
Mississippi	3	16,400	20,000	3,000	4,800	9,300	16,300	2,500	1,800	2,500	.....	.....	225	3,200
Missouri	1	75,060	78,500	7,200	14,300	35,500	2,000	14,000	20,000	3,800	2,200	.....	400	3,000
Montana	10	87,400	97,885	29,750	19,855	31,400	19,600	11,200	39,560	2,300	3,988	.....	200	17,310
Nebraska	1	2,800	3,000	.....	1,100	.....	.....	800	.....	.....	.....	.....	.....	.....
New Jersey	7	553,550	586,440	229,015	45,035	178,890	53,556	78,835	154,600	18,055	7,675	8,000	800	24,600
New Mexico	5	29,175	31,700	6,300	2,000	8,850	3,900	3,950	2,800	2,000	.....	.....	.....	2,100
New York	3	89,500	95,400	35,000	.....	39,500	19,700	16,000	18,500	2,800	2,300	.....	.....	6,600
North Dakota	2	46,600	49,000	.....	1,000	18,000	7,000	6,700	.....	1,800	1,440	.....	.....	.....
Ohio	10	432,017	455,555	110,100	79,390	208,290	94,100	86,835	69,600	12,955	13,485	3,300	790	20,600
Oklahoma	14	406,800	426,505	131,935	79,155	169,370	74,235	72,770	61,390	20,221	11,170	10,950	1,210	10,525
Oregon	1	6,400	7,000	7,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,500
Pennsylvania	13	670,450	705,450	224,600	125,585	247,575	57,260	165,455	178,315	22,475	8,155	28,340	.....	9,390
Rhode Island	2	14,700	16,685	6,840	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,670
South Carolina	1	11,440	13,000	10,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,949
Tennessee	1	19,500	20,000	5,000	.....	7,000	1,900	.....	.....	1,200	200	.....	.....	3,000
Texas	59	2,584,840	2,735,530	834,622	427,690	962,950	273,500	569,605	678,155	122,475	27,656	77,500	1,165	45,700
Utah	5	101,065	105,215	37,700	1,500	38,150	11,500	16,100	1,000	5,000	1,100	.....	.....	2,850
Virginia	1	36,800	38,000	21,000	14,000	22,000	9,000	7,600	22,600	.....	2,500	.....	700	.....
Washington	6	159,700	169,370	60,950	8,600	68,775	25,610	27,890	50,220	6,355	6,820	.....	.....	8,200
West Virginia	2	6,571	7,300	2,000	2,150	.....	.....	2,500	2,500	.....	75	1,600	.....	.....
Wisconsin	2	17,250	20,000	6,000	1,300	.....	.....	3,100	5,000	.....	.....	.....	.....	2,300
Wyoming	9	110,050	120,095	48,775	21,245	42,315	14,515	15,895	28,990	3,240	2,285	840	193	13,220
Puerto Rico	2	89,600	97,200	78,996	20,000	35,000	29,200	7,454	14,954	1,425	2,905	.....	.....	.....
Total	298	9,933,725	10,499,820	3,475,939	1,903,555	3,656,900	1,357,386	1,963,214	2,218,559	425,091	150,419	189,870	16,903	448,564

*For state totals, calendar-day figures reported by some companies were converted to stream-day basis.

Where the plants are, their capacities, and types of processing

LEGEND

Processes in table are identified by numbers:

THERMAL PROCESSES
1. Gas-oil cracking
2. Visbreaking
3. Naphtha reforming
4. Fluid coking
5. Delayed coking
6. Batch coking
7. Polyforming
8. Cracking, general
9. Residuum cracking
10. Clarified cracking

CATALYTIC CRACKING
1. Fluid
2. Thermofor
3. Houdriflow
4. Houdry
5. Cycloversion

CATALYTIC REFORMING
1. Platforming
2. Fluid hydroforming
3. Fixed-bed hydroforming
4. Houdriforming
5. Ultraforming
6. Catforming
7. Sinclair-Baker
8. Powerforming
9. Rexforming
10. Iso-Plus
11. Hyperforming
12. Cycloversion
13. Socony-Mobil
14. Thermofor
15. Own
16. Undefined

NR—Not reported

CATALYTIC HYDROGEN TREATING
1. Unifining
2. Esso Hydrofining
3. Indiana Hydrofining
4. Hydrotreating
5. Gulfining
6. Houdry
7. Shell vapor phase
8. Shell Trickle
9. Diesulforming
10. Sinclair
11. Kellogg
12. Platreating
13. Socony-Mobil
14. Own
15. Undefined
16. Hydrobon

ALKYLATION
1. Sulfuric acid
2. Hydrofluoric acid

POLYMERIZATION
1. Thermal
2. Catalytic

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking: Fresh Feed	Catalytic Cracking: Recycle	Catalytic Reforming	Hydrogen Treating: Unit	Hydrogen Treating: Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
Alabama														
American Bitumuls & Asphalt Co.														
Mobile (Blakely Island)	6,000	6,500	6,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,300
Hunt Oil Co.														
Tuscaloosa	8,000	8,420	3,850	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,000
Vulcan Asphalt Refining Co.														
Cordova	1,900	2,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,100
Warrior Asphalt Corp.														
Holt	1,250	1,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	700
Total	17,150	18,420	10,350	.....	.....	.....	.....	.....		.....	.....	.....	.....	9,100
Arkansas														
American Oil Co.														
El Dorado	40,000	42,000	20,000	[1]3,000 [5]10,000	[1]19,000	4,000	[5]12,240	[3]12,500	SR naph	[2]1,500	[2]500	.....	400	.....
Berry Asphalt Co.														
Stephens	1,800	2,000	2,000	.....	.....	.....	.....	.....	.....	.....	.....	500	.....	600
Waterloo	1,500	1,800	1,800	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	800
Cross Co., Henry H.														
Smackover	3,500	3,685	1,500	.....	.....	.....	.....	.....	.....	.....	.....	900	.....	1,200
Lion Oil Co., Div. of Monsanto Chemical Co.														
El Dorado	33,600	34,500	16,500	.....	[1]7,400 [2]7,000	4,200	[1]4,500	[1]5,000 [1]5,000	SR naph. Mid. dist.	[1]2,000	[2]1,800	800	.....	5,600
Macmillan Petroleum Corp.														
Norphlet	4,275	4,500	4,500	.....	.....	.....	.....	.....	.....	.....	.....	2,500	.....	1,500
Total	84,675	88,485	46,300	13,000	33,400	8,200	16,740	22,500		3,500	2,300	4,700	400	9,700

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking: Fresh Feed	Catalytic Cracking: Recycle	Catalytic Reforming	Hydrogen Treating: Unit	Hydrogen Treating: Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
California														
Caminol Co.														
Hanford	7,500	7,500		[1]700 [2]2,600 [3]350			[1]1,350				[1]150			
Century Oil Co.														
Signal Hill	5,500	5,500	5,500											
Douglas Oil Co. of California														
Bakersfield	9,410	9,800		*4,600			[1]2,200	[1]1,700	SR naph.		[2]40			
Paramount	7,500	8,100	6,000											4,000
Santa Maria	3,350	3,500	2,800											2,800
Edgington Oil Refineries, Inc.														
Long Beach	7,125	7,500										1,500		3,000
Oxnard	3,325	3,500												2,625
Envoy Petroleum Co.														
Long Beach	3,000	3,160												1,500
Fletcher Oil Co.														
Wilmington	9,500	10,000		[2]4,500							[2]150			
Golden Bear Oil Co.														
Oildale	5,350	5,500	5,500									2,750		2,000
Golden Eagle Refining Co., Inc.														
Torrance	8,500	9,000		[2]4,500							[2]90			
Macmillan Petroleum Corp.														
Long Beach	8,550	9,000												1,200
Manespo Refining Co.														
Long Beach	3,000	3,000												
Mobil Oil Co.														
Torrance	125,000	128,000	38,000	[1]7,500 [2]16,000 [5]35,800	[2]28,000	24,000	[13]20,000	[13]23,400	SR & crkd. naph.	[2]4,200	[2]900		1,450	
Mohawk Petroleum Corp.														
Bakersfield	12,500	13,200		[1]1,500 [2]3,170			[1]2,500	[1]925	SR naph.		[2]60			
Newhall Refining Co., Inc.														
Newhall	3,400	4,000	900											900
Oxnard Oil & Refining Co.														
Oxnard	1,800	1,800												
Palomar Oil & Refining Corp.														
Bakersfield	1,300	1,300	1,300									400		500
Powerine Oil Co.														
Santa Fe Springs	14,000	15,400		[1]5,000			[1]2,700				[2]150			
Richfield Oil Corp.														
Watson (Los Angeles County)†	165,000	173,700	75,000	[1]23,000 [2]37,000	[1]42,000 [2]19,500	20,000 10,500	[7]32,000	[4]18,000 [15]32,000	Crkd. naph. SR naph.	[7]7,000	[2]2,200			3,500
Seaside Oil Co.														
Ventura	5,500	5,500												
Shell Oil Co.														
Martinez	55,000	58,000	11,600	[1]29,600			[1]5,400					3,800		8,000
Wilmington-Dominguez†	68,000	70,000	42,000	[1]36,000	[1]24,000	9,000	[1]19,600	[7]21,000 [7]11,000	SR naph. Cat. gaso.	[1]6,500				
Signal Oil & Gas Co.														
Bakersfield	15,000	15,300	10,000	[1]2,500 [4]5,500	[2]8,000	8,000	[7]3,750			[1]1,000	[2]500		100	
Socal Oil & Refining Co.														
Huntington Beach	2,850	3,000		[1]3,000										500

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking Fresh Feed	Catalytic Cracking Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
CALIFORNIA (Continued)														
Standard Oil Co. of Calif., Western Operations, Inc.														
Bakersfield‡	26,000	NR		[9]9,000			[1]5,000	[1]45,000	Other					1,110
El Segundo‡	150,000	NR	76,000	[3]11,000 [9]59,000	[1]40,000	15,000	[1]30,000	[1]420,000	Other	[1]5,400				8,325
Richmond†‡§	210,000	NR	50,000	[2]7,500 [9]50,000	[1]40,000 [2]32,000	15,000 10,000	[1]40,000	[1]440,000	Other	[1]4,500 [2]4,000		10,000		11,100
Sunland Refining Corp.														
Bakersfield	4,500	4,730		[2]1,100			[1]1,000							
Texaco Inc.														
Wilmington†‡	60,000	NR	35,000	[1]10,000	[1]28,000		[1]21,000	[4]21,000	SR naph.	[1]4,400				
Tidewater Oil Co.														
Avon†	135,000	142,000	74,500	[1]20,000 [4]42,000	[1]47,000		[1]10,000 [4]22,500	[1]34,500	SR naph.	[1]6,000		1,670	1,200	
Union Oil Co. of California														
Arroyo Grande (Santa Maria)	21,500	24,500		[5]15,000									720	
Rodeo (Oleum)	45,800	48,200	34,100	[1]15,000 [5]15,000			[1]14,500	[1]17,000	SR naph.			2,600	500	3,600
Santa Maria (Orcutt)	4,700	5,000	1,500											3,000
Wilmington (Los Angeles)†	109,000	115,000	112,000	[1]16,000 [2]18,500	[1]26,000 [2]16,000	8,000 8,000	[1]13,000 [7]15,000	[1]39,000 [1]6,500	SR naph. Hvy. crkd. gaso.	[1]5,000				6,700
West Coast Oil Co.														
Oildale	3,500	3,685												2,000
Wilshire Oil Co. of California														
Santa Fe Springs	32,000	33,000	10,000	[1]7,000	[1]9,500	1,000	[1]10,000	[1]8,000 [1]2,000	SR naph. Crkd. naph.	[2]1,500	[2]800			2,000
Total¶	1,352,960	1,419,850	600,175	535,195	375,555	145,390	282,170	310,580		51,535	5,040	23,830	3,970	70,645

*Topped crude. †The following butane isomerization units are operating: Richfield at Watson, 1,000 b.p.s.d.; Shell at Wilmington-Dominguez, 3,800 b.p.s.d.; Standard of California at Richmond, 2,000 b.p.c.d.; Texaco at Wilmington, 1,500 b.p.c.d.; Tidewater at Avon, 2,700 b.p.s.d.; and Union at Wilmington (Los Angeles), 1,500 b.p.s.d. ‡Stream-day figures not reported. All figures are calendar day. §Includes Isocracking unit at 1,000 b.p.c.d. ¶State totals include calendar-day figures converted to stream-day basis. Cat cracking recycle total includes the figures of one major company which are not reported in main table (with recycle estimated at 40% of fresh feed).

Colorado

Continental Oil Co.														
Denver	15,000	18,000	2,200	[1]4,700	[2]7,800	3,700	[1]63,500				[2]750			
Empire Petroleum Co.														
Denver	4,750	5,000	4,000											1,500
Oriental Refining Co.														
Alamosa	1,000	1,000		[1]600										
Denver	3,300	3,300		[1]1,500										
Skelly Oil Co.														
Denver	1,400	1,500		[1]800			[1]650							
Tenneco Oil Co. (Tennessee Gas Transmission Co. subsidiary, formerly Bay Div. of TGT)														
Denver	10,000	11,000	3,000	[2]6,000	[1]4,500	2,000	[7]3,800				[2]600			
Uinta Oil Refining Co.														
Rangely	1,400	1,500												
Total	36,850	41,300	9,200	13,600	12,300	5,700	7,950				1,350			1,500

NOW MIDGET CYCLONES REPLACE THICKENERS ON

An individual 10 mm dia. cyclone illustrating sealing arrangement.

New manifolded units only 18 inch dia. replace 25 foot dia. thickeners...

A major breakthrough in refinery processing techniques is now possible with the TMC DorrClone. By manifolding miniature cyclones in common housings, tremendous centrifugal force is available to separate 5 micron and above particles from production scale streams. Each individual cyclone is only 10 mm inside diameter and is constructed of a special ceramic material that is thermally and mechanically shockproof. Housings are forged carbon steel or stainless steel and pressure tested to 400 psig before shipment. Specifications for the various TMC sizes are shown on the opposite page and major advantages are listed below.

SAFETY: Individual TMC DorrClones are constructed according to code with ⅛" corrosion allowance. Construction and installation completely eliminate dangerous spills and boil overs from accidental crude or water injection. Completely closed construction makes it as safe as the pipe work connecting it to the system.

SPACE: 2 cu. ft. of space now do the job of 8500 cu. ft. No foundations required. Can be supported by its own piping.

EFFICIENCY: 95% removal of 5 micron and above solids. Operation at higher temperatures than ever before possible with resultant heat savings. Far more effective than pressure decanters. Ratio of clarified oil to slurry oil can be controlled through a 50-1 to 1-3 range.

COST: 75% reduction on installed costs as compared with thickeners.

MAINTENANCE: No moving parts – greatly reduced areas of lagging. Replacement periods exceed by far T & I intervals.

For further information on this new innovation, simply fill out the coupon at right or write direct to Dorr-Oliver Incorporated, Stamford, Conn.

DORR-OLIVER

WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

Exploded view of TMC-60 with several cyclones removed.

CATALYST RECOVERY STREAMS

SPECIFICATIONS		TMC–60	TMC–180	TMC–300
Capacity BPD		1000–2000	4000–6000	7000–10,000
Overall Dimensions	Height, inches	17	24	30
	Diameter, inches	18	30	36
Weight, (approx.) lbs.		200	400	800
Pressure psig		150	150	150
Temperature, ° Fahrenheit		850	850	850

To: O. M. Johnson
Dorr-Oliver Incorporated
Stamford, Connecticut

I am interested in the possible application of a TMC DorrClone to our Catalyst Separating System. Our conditions are:

Flow BPD_____
Catalyst Size_____
Catalyst %_____
Operating Temp._____
Operating Press._____

NAME_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE_____ STATE_____

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking Fresh Feed	Catalytic Cracking Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
Delaware														
Texaco Inc.														
Claymont (discontinuing operations in 1961)*	3,500	NR	1,750											1,500
Tidewater Oil Co.														
Delaware City	140,000	150,000	90,700	[4]42,000	[1]58,000	44,000	[4]45,000	[1]48,000 [1]30,000 [1]10,000	Mid. dist. SR naph. Cat. gaso.	[1]5,000	[2]5,100		1,200	
Total†	143,500	153,685	92,644	42,000	58,000	44,000	45,000	88,000		5,000	5,100		1,200	1,670

*Stream-day figures not reported. All figures are calendar day. †State totals include calendar-day figures converted to stream-day basis.

Florida

Seminole Asphalt Refining, Ltd.														
St. Marks	2,000	2,200												1,100

Georgia

American Oil Co.														
Savannah	7,000	8,000												5,500
Cracker Asphalt Corp.														
Douglasville	1,800	2,250												1,420
Total	8,800	10,250												6,920

Hawaii

Standard Oil Co. of Calif., Western Operations, Inc.														
Honolulu*	32,000	NR												555

*Stream-day figures not reported. All figures are calendar day.

Illinois

Advance Refining Co., Inc.														
Centralia	3,000	3,000					[12]600							
American Oil Co. (formerly Standard Oil Co. of Indiana)														
Wood River	75,800	78,000	28,860		[1]30,000	21,000	[5]9,200	[3]13,000	SR naph.	[1]5,300	[2]500			9,500
Clark Oil & Refining Corp.														
Blue Island	35,000	35,500	14,000	[1]1,800	[1]14,000 [3]7,200	9,000	[1]7,200			[2]2,300	[2]600			
Cross Co., Henry H.														
Colmar	1,000	1,055												
Mobil Oil Co.														
East St. Louis	43,500	50,000		[5]13,000	[2]23,000	8,000	[13]12,000	[13]16,000	SR naph.	[2]2,400	[2]600		300	
Ohio Oil Co.														
Robinson	48,800	50,000	18,050	[1]6,600 [5]7,500	[1]22,000	8,000	[4]10,000			[1]2,600	[2]1,500		300	
Pana Refining Co., Div. of Illinois Farm Supply Co.														
Pana	5,000	5,500		[1]2,500			[1]1,500	[1]2,150	SR naph.		[2]145			
Pure Oil Co.														
Lemont	47,500	NR		[1]3,000	[1]22,000	6,000	[7]12,000	[11]17,000	SR naph.	[2]1,600	[2]1,800			5,500

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking: Fresh Feed	Catalytic Cracking: Recycle	Catalytic Reforming	Hydrogen Treating: Unit	Hydrogen Treating: Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
ILLINOIS (Continued)														
Shell Oil Co.														
Wood River*	186,000	194,000	76,000	[1]16,300 [3]12,000 [6]14,800	[1]65,000	25,000	[1]42,200	[7]26,500 [7]34,000 [7]15,000	SR naph. Mid. dist. Range fuel	[1]12,000	[2]1,250	4,100	900	13,100
Sinclair Refining Co.														
Hartford (Wood River refinery)	29,500	31,000	12,000	[1]6,000	[1]11,000	550	[7]7,500	[10]7,500	SR naph.	.....	[2]800	.....	.....	1,500
Texaco Inc.														
Lawrenceville†	67,000	NR	20,000	[1]12,000	[1]30,000	.....	[1]24,000	[1]24,000	SR naph.	[1]2,300	[2]2,500	.....	.....	2,700
Lockport†	67,000	NR	13,500	[1]15,000 [5]9,500	[1]30,000	.....	[1]19,000	[1]19,000	SR naph.	[1]4,400	[2]600	.....	250	3,200
Wireback Oil Co.														
Plymouth	1,200	1,200	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total‡	610,300	640,305	184,172	124,055	260,870	104,220	149,980	178,925		33,645	10,635	4,100	1,775	36,155

*Includes 3,000-bbl. butane isomerization unit. †Stream-day figures not reported. All figures are calendar day. ‡State totals include calendar-day figures converted to stream-day basis. Cat cracking recycle total includes the figures of one major company which are not reported in main table (with recycle estimated at 40% of fresh feed).

Indiana

Allby Asphalt & Refining Corp.														
Hammond	9,500	10,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,000
American Oil Co. (formerly Standard Oil Co. of Indiana)														
Whiting	222,000	235,000	107,500	[1]11,500 [5]24,000	[1]88,000	20,000	[5]56,000	[3]70,000	SR naph.	[1]5,300	[2]1,200	7,000	1,220	10,000
Berry Refining Co.														
Gary	17,000	18,000	4,000	.....	.....	.....	[1]2,000	[1]2,000	SR naph.	.....	.....	.....	.....	2,000
Cities Service Petroleum Co.														
East Chicago	58,000	58,000	.....	[5]24,000	[1]22,500	7,500	[2]13,000 [7]8,000	.....	.....	[1]2,560	.....	.....	440	.....
Gladieux Refinery, Inc.														
Fort Wayne	2,185	2,300	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Indiana Farm Bureau Coop. Association, Inc.														
Mount Vernon	11,875	12,500	4,200	[2]3,000	[1]3,960	.....	[1]3,000	[1]2,100	Mid. dist.	.....	[1]88 [2]262	.....	.....	.....
Jarvis Refining Co.														
Troy	1,500	1,550	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Laketon Asphalt Refining, Inc.														
Laketon	4,500	4,730	2,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,350
Mobil Oil Co.														
East Chicago	36,000	39,300	9,500	[1]7,500	[2]17,500	2,000	[1]39,500	[13]13,000	SR naph.	[1]3,000	.....	.....	.....	.....
R. J. Oil & Refining Co., Inc.														
Princeton	3,990	4,200	.....	[1]2,000	.....	.....	[1]785	.....	.....	.....	.....	.....	.....	.....
Rock Island Refining Corp.														
Rock Island (Indianapolis)	22,000	24,000	12,000	[2]7,200	[1]8,300	1,700	[1]3,000	[1]6,000	SR naph.	.....	[2]650	.....	.....	1,300
Sinclair Refining Co.														
East Chicago	114,000	120,000	47,000	[1]12,000 [2]18,000	[1]36,000	7,200	[7]20,000	[10]3,500	Lube oils	[1]5,000	[2]2,450	2,750	.....	4,000
Total	502,550	529,580	186,200	109,200	176,260	38,400	115,285	96,600		15,860	4,650	9,750	1,660	23,650

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking Fresh Feed	Catalytic Cracking Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
Kansas														
American Oil Co. (formerly Standard Oil Co. of Indiana)														
Neodesha	28,640	30,400	.....	.....	[1]10,000	1,000	[5]7,200	[3]7,200	SR naph.	[1]1,300	.....	.....	.....	.....
American Petrofina Co. of Texas														
El Dorado	19,000	20,000	6,000	.....	[1]6,000	4,000	[1]2,500	.....	.....	.....	[2]450	.....	.....	1,900
Anderson-Prichard Oil Corp.														
Arkansas City	25,000	26,000	5,000	[1]3,500	[1]7,500	4,800	[1]5,000	.....	.....	[2]2,200	.....	.....	.....	1,300
Century Refining Co.														
Shallow Water	4,000	4,200	2,000	.....	[2]3,000	3,000	.....	.....	.....	[2]1,200	.....	.....	.....	400
Cooperative Refinery Association														
Coffeyville	24,500	25,500	6,000	[5]8,000	[1]10,000	8,500	[1]4,200	[1]2,300	Mid. dist.	[2]1,200	[2]500	1,200	150	1,200
Phillipsburg	13,000	14,000	4,500	.....	[1]5,000	4,500	[1]2,500	[1]3,500	SR naph.	.....	[2]750	.....	.....	1,600
Derby Refining Co.														
Wichita	19,250	20,500	6,800	*[1]3,000	[2]7,500	4,500	[5]2,500	[2]4,000	SR naph.	[2]1,600	*[2]600	.....	.....	2,000
Mid-America Refining Co., Inc.														
Chanute	2,850	3,000	1,600	[1]1,200	.....	.....	.....	.....	.....	.....	.....	.....	.....	500
Mobil Oil Co.														
Augusta	45,000	47,000	16,000	[1]4,100	[2]18,800	5,200	[1][3]10,500	.....	.....	[2]2,400	.....	.....	.....	7,000
National Cooperative Refinery Association														
McPherson	31,000	33,000	.....	[1]2,000 [5]12,000	[1]13,500	6,000	[1]5,000	[1]8,000	SR naph.	[2]2,300	[2]1,000	.....	250	.....
Phillips Petroleum Co.														
Kansas City	70,000	NR	15,000	.....	[1]24,000	16,000	[1]16,000	.....	.....	[2]6,600	.....	2,400	.....	2,400
Skelly Oil Co.														
El Dorado	45,000	48,000	24,000	[1]6,500 [5]8,500	[1]20,000	2,500	[1]15,000	[1]10,000	SR naph.	[2]3,500	[2]1,400	.....	500	3,000
Vickers Petroleum Co., Inc.														
Potwin	16,000	17,200	3,000	[1]3,400 [3]1,500	[2]8,200	2,000	[5]3,100	[4]3,100	SR naph.	.....	[2]800	.....	.....	.....
Total†	343,240	362,485	89,900	53,700	133,500	62,000	73,500	38,100		22,300	5,500	3,600	900	21,300
Kentucky														
Ashland Oil & Refining Co.														
Catlettsburg	75,000	80,000	18,000	[1]6,000 [3]2,000	[1]32,000	12,000	[1][5]6,500	[1][4]10,000	SR naph.	.....	[2]4,000	.....	.....	7,000
Louisville Refining Co.														
Louisville	14,200	15,000	6,000	[1]2,500	[1]5,000	4,200	[1]2,500	[1]2,500	SR naph.	.....	[2]400	.....	.....	.....
Sohio Petroleum Co.														
Latonia	16,500	18,000	10,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,000
Somerset Refinery, Inc.														
Somerset	1,500	1,550	.....	.....	[5]400	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	107,200	114,550	34,000	10,500	37,400	16,200	9,000	12,500		.....	4,400	.....	.....	12,000
Louisiana														
Atlas Processing Co.														
Shreveport*	17,500	19,000	.....	†[3]2,000	.....	.....	[1]7,400	.....	.....	.....	†[2]500	.....	.....	.....
Bayou State Oil Corp.														
Hosston	847	1,000	565	.....	.....	.....	.....	.....	.....	.....	.....	460	.....	245

*Shut down. †State crude-capacity totals include calendar-day figures converted to stream-day basis.

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking: Fresh Feed	Catalytic Cracking: Recycle	Catalytic Reforming	Hydrogen Treating: Unit	Hydrogen Treating: Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
LOUISIANA (Continued)														
Calumet Refining Co.														
Princeton	1,850	2,050	2,050	.....	.....	.....	.....	.....	.....	.....	.....	800	.....	410
Canal Refining Co.														
Church Point	1,700	1,800	.....	.....	.....	.....	[6]750	.....	.....	.....	.....	.....	.....	.....
Cities Service Refining Corp.														
Lake Charles‡	185,000	190,700	32,000	[2]12,000	[1]88,000	62,000	[2]20,000	.....	.....	[1]17,000	.....	.....	.....	.....
Continental Oil Co.														
Westlake (Lake Charles)	53,000	57,500	.....	[1]6,800 [5]10,000	[2]21,200	7,500	[1]6,800 [1&6]11,000	[1&4]11,000	SR naph.	[1]2,800	[2]800	.....	325	.....
Cotton Valley Solvent Co.														
Cotton Valley§	4,750	5,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Evangeline Refining Co., Inc.														
Jennings	2,000	2,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Humble Oil & Refining Co.														
Baton Rouge	365,000	378,000	130,000	[1]35,000 [2]13,000	[1]142,500	60,800	[8]38,000	[2]3,600 [2]9,560 [2]1,760	Solvent Lube oil Wax	[1]25,000	[2]7,400	12,100	.....	11,000
Ida Gasoline Co., Inc.														
Ida	810	850	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ingram Oil & Refining Co.														
Meraux	19,000	20,000	7,500	.....	[1]5,850	1,500	[1]3,500	.....	.....	.....	[2]370	.....	.....	.....
Shell Oil Co.														
Norco	102,000	107,000	47,000	[1]14,200 [3]4,700	[1]66,000	27,000	[1]18,500	[7]19,000	SR naph.	[1]7,900	[2]1,700	.....	.....	1,840
Tenneco Oil Co. (Tennessee Gas Transmission Co. subsidiary, formerly Bay Div. of TGT)														
Chalmette	41,000	45,000	9,500	.....	[1]17,000	10,000	[1]6,000	.....	.....	[2]3,000	.....	.....	.....	.....
Total	794,457	830,400	228,615	97,700	340,550	168,800	111,950	44,920		55,700	10,770	13,360	325	13,495

*Basic feed stock is extraction-plant gasoline mixed with crude. This plant also includes a 3,730-bbl. pentane and heavier isomerization unit. †Not operating. ‡The 12,000-bbl. combination thermal reforming-thermal cracking unit currently being used for visbreaking operations. This plant also includes 4,800-bbl. butane isomerization unit. §Fractionates crude and condensate into straightrun products.

Maryland

American Bitumuls & Asphalt Co.														
Baltimore (Fairfield)	6,900	7,500	7,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,600
American Oil Co.														
Baltimore	9,000	9,300	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,500
Humble Oil & Refining Co.														
Baltimore	16,500	19,000	11,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8,600
Total	32,400	35,800	18,500	.....	.....	.....	.....	.....		.....	.....	.....	.....	19,700

Massachusetts

Humble Oil & Refining Co.														
Everett	50,000	55,000	13,100	.....	[1]20,000	19,000	[6]7,200	[2]7,200	SR naph	.....	[2]1,800	.....	.....	10,000

Michigan

Aurora Gasoline Co.														
Detroit	44,000	47,000	34,000	[2]7,000 [4]4,000	[1]17,000	3,000	[1]5,500	[1]10,000 [1]10,000	SR naph. Gas oil	[1]2,000	[2]1,400	.....	150	6,500

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking Fresh Feed	Catalytic Cracking Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
MICHIGAN (Continued)														
Muskegon	14,500	16,000	8,000	.....	[1]7,000	1,400	[1]2,400	[1]2,500 [1]700	SR naph. Mid. dist.	.....	[2]600	.....	.....	3,000
Bay Refining Co., Div. of Dow Chemical Co.														
Bay City	22,000	23,160	5,500	.....	[2]3,600	2,100	.....	.....	.....	[2]750	[2]750	.....	.....	.....
Crystal Refining Co.														
Carson City	6,200	6,525	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lakeside Refining Co.														
Kalamazoo	4,275	4,500	.....	.....	[5]1,500	.....	[7]1,000	.....	.....	.....	.....	.....	.....	.....
Leonard Refineries, Inc.														
Alma (Leonard Division)	9,500	10,500	9,000	.....	[1]7,500 [2]5,600	5,500 1,400	[5]2,400	[2]3,800 [2]1,400 [3]2,400	Cat. feed Mid. dist. SR naph.	[2]1,100	[2]140	.....	.....	2,800
Alma (Mid-West Division)	10,000	11,000	.....	[2]3,000	.....	.....	[1]2,200	.....	.....	.....	.....	.....	.....	.....
Mount Pleasant (Roosevelt Division)	7,500	7,700	.....	.....	.....	.....	[1]1,800	[4]500	SR naph.	.....	.....	.....	.....	.....
Marvel Refining Co.														
Grand Rapids	1,500	1,500	.....	[3]500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mobil Oil Co.														
Trenton	33,500	38,000	.....	[5]6,300	[2]15,000	7,200	[1]9,000	[1]10,500 [1]1,000	SR naph. Crkd. naph.	[1]3,500	.....	.....	240	.....
Naph-Sol Refining Co.														
Muskegon	9,500	10,000	.....	[3]3,100	.....	.....	[1]1,100	[1]2,500 [1]2,500	SR naph. Mid. dist.	.....	[2]60	.....	.....	.....
Osceola Refining Co., Inc.														
Reed City	2,500	2,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Petroleum Specialties, Inc.														
Flat Rock	6,000	6,500	.....	.....	.....	.....	[1]900	[1][5]1,500	SR naph.	.....	.....	.....	.....	.....
Upper Peninsula Oil Refinery, Inc.														
Rapid River	1,500	1,610	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
West Branch Refineries, Inc.														
West Branch	5,000	5,000	.....	.....	.....	.....	[4]1,150	[6]1,150	SR naph.	.....	.....	.....	.....	.....
Total	177,475	191,495	56,500	23,900	57,200	20,600	27,450	50,450		7,350	2,950	.....	390	12,300
Minnesota														
Great Northern Oil Co.														
Pine Bend (St. Paul)	37,000	39,000	.....	[5]12,000	[2]19,000	6,000	[5]5,000	[2]5,000 [2]8,500 [2]2,500	SR naph. Mid. dist. Other	[1]1,600	[2]1,200	.....	600	.....
International Refineries, Inc.														
Wrenshall	14,000	15,000	.....	.....	[1]3,500	1,500	[8]2,800	[2]2,800	SR naph.	.....	[2]270	.....	.....	.....
Northwestern Refining Co.														
New Brighton	2,500	2,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
St. Paul Park	17,000	17,000	10,000	.....	[1]6,500	4,500	.....	.....	.....	.....	[2]500	.....	.....	5,000
Total	70,500	73,500	10,000	12,000	29,000	12,000	7,800	18,800		1,600	1,970	.....	600	5,000
Mississippi														
Paluxy Asphalt Co.														
Yazoo City	1,700	2,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	700
Pontiac Eastern Corp.														
Hattiesburg	10,500	11,500	.....	[4]4,800	[2]9,300	16,300	[1]2,500	[1]1,200	Cat. recycle	[1]2,500	.....	.....	225	.....
Southland Co.														
Sandersville	4,200	6,500	3,000	.....	.....	.....	.....	[1][5]600	Crkd. naph.	.....	.....	.....	.....	2,500
Total	16,400	20,000	3,000	4,800	9,300	16,300	2,500	1,800		2,500	.....	.....	225	3,200

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking: Fresh Feed	Catalytic Cracking: Recycle	Catalytic Reforming	Hydrogen Treating: Unit	Hydrogen Treating: Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
Missouri														
American Oil Co. (formerly Standard Oil Co. of Indiana)														
Sugar Creek	75,060	78,500	7,200	[5]14,300	[1]35,500	2,000	[5]14,000	[3]20,000	SR naph.	[1]3,800	[2]2,200	.....	400	3,000
Montana														
Big West Oil Co. of Montana														
Kevin	2,700	3,000	700	*[6]1,250	.....	.....	[1]1,000	[1]1,250	SR naph.	.....	[3]20	.....	.....	225
Continental Oil Co.														
Billings	12,900	14,800	.....	.....	[1]5,800	6,200	[1][6]2,500	[1]3,000	SR naph.	.....	[2]560	.....	.....	1,660
								[1]4,500	Mid. dist.					
Diamond Asphalt Co.														
Chinook	1,000	1,000	450	[3]150	.....	.....	[1]150	[1]150	SR naph.	.....	.....	.....	.....	1,000
Farmers Union Central Exchange														
Laurel	19,000	20,000	17,000	[2]6,000	[1]8,000	1,000	[1]4,450	[1]5,160	SR naph.	.....	[1]108	.....	.....	5,600
								[1]7,100	Mid. dist.		[2]665			
Humble Oil & Refining Co.														
Billings	34,000	40,000	10,000	[4]4,200	[1]16,500	10,500	[6]2,500	[2]10,500	SR naph.	[2]2,300	[2]2,400	.....	200	7,800
								[2]7,000	Mid. dist.					
Jet Fuel Refinery Co.														
Mosby	1,200	1,265	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Phillips Petroleum Co.														
Great Falls	3,800	NR	1,600	.....	[1]1,100	1,900	.....	.....	.....	.....	[2]50	.....	.....	525
Texaco Inc.														
Sunburst (to be shut down in 1961)†	8,000	NR	.....	[1]5,000	.....	.....	.....	.....	.....	.....	[2]100	.....	.....	.....
Union Oil Co. of California														
Cut Bank	3,800	4,200	.....	[1]400	.....	.....	[7]600	[1]900	Mid. dist.	.....	[2]75	.....	.....	.....
				[2]2,300										
Unity Petroleum Corp.														
Kalispell	1,000	1,200	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	500
Total‡	87,400	97,885	29,750	19,855	31,400	19,600	11,200	39,560		2,300	3,988	.....	200	17,310

*Charges topped crude. †Stream-day figures not reported. All figures calendar day. ‡State totals include calendar-day figures converted to stream-day basis.

Nebraska														
Cooperative Refinery Association														
Scottsbluff	2,800	3,000	.....	[1]1,100	.....	.....	[1]800	.....	.....	.....	.....	.....	.....	.....
New Jersey														
California Oil Co.														
Perth Amboy	115,500	123,000	65,000	[2]5,000	[3]29,000	2,000	[1]21,000	[1]10,000	SR naph.	[1]2,500	[2]400	.....	.....	5,500
Cities Service Oil Co. (Pa.)														
Linden	14,300	15,000	10,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8,900
Hess Trading & Transport, Inc.														
Sewaren	71,250	75,000	.....	.....	.....	.....	[1]4,000	[1]5,000	SR naph.	.....	.....	.....	.....	.....
								[1]5,000	Mid. dist.					
Humble Oil & Refining Co.														
Bayonne	22,500	25,000	13,900	.....	.....	.....	.....	[2]3,600	Wax	.....	.....	.....	.....	10,200
Linden (Bayway refinery)	170,000	180,000	73,800	[2]8,000	[1]85,000	22,000	[6]20,000	[2]35,000	SR naph.	[1]10,700	[2]4,500	.....	.....	.....
								[2]30,000	Mid. dist.					
Mobil Oil Co.														
Paulsboro	87,000	91,600	40,000	[5]18,700	[2]26,000	14,000	[1][3]20,500	[1][3]20,000	SR naph.	[2]2,300	.....	8,000	800	.....
								[1][3]26,000	Mid. dist.					

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking: Fresh Feed	Catalytic Cracking: Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
NEW JERSEY (Continued)														
Petroleum Separating Co.														
Bayonne	(See table of plants that are shut down)													
Texaco Inc.														
Westville*	73,000	NR	25,000	[2]12,000	[1]35,000	.....	[1]12,000	[1]12,000 [4]6,000	SR naph. Mid. dist.	[1]2,300	[2]2,500	.....	.....	.....
Total†	553,550	586,440	229,015	45,035	178,890	53,556	78,835	154,600		18,055	7,675	8,000	800	24,600

*Stream-day figures not reported. All figures are calendar day. †State totals include calendar-day figures converted to stream-day basis. Cat cracking recycle total includes the figures of one major company which are not reported in main table (with recycle estimated at 40% of fresh feed).

New Mexico

Beeline Refining Co., Div. of Frontier Refining Co. (formerly Four States Western Oil Refining Co.)														
Farmington	1,400	1,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Continental Oil Co.														
Artesia	15,500	17,000	2,900	[1]2,000	[2]6,000	1,400	[4]1,500	[1][4]2,000	SR naph.	[2]1,000	.....	.....	.....	2,100
El Paso Natural Gas Products Co.														
Ciniza (Gallup)	8,100	9,000	3,400	.....	[1]2,850	2,500	[1]1,800	.....	.....	[1]1,000	.....	.....	.....	.....
Famariss Oil & Refining Co.														
Monument	1,675	1,700	.....	.....	.....	.....	[1]650	[1]720 [1]80	SR naph. Mid. dist.	.....	.....	.....	.....	.....
Plateau, Inc.														
Bloomfield	2,500	2,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	29,175	31,700	6,300	2,000	8,850	3,900	3,950	2,800		2,000	.....	.....	.....	2,100

New York

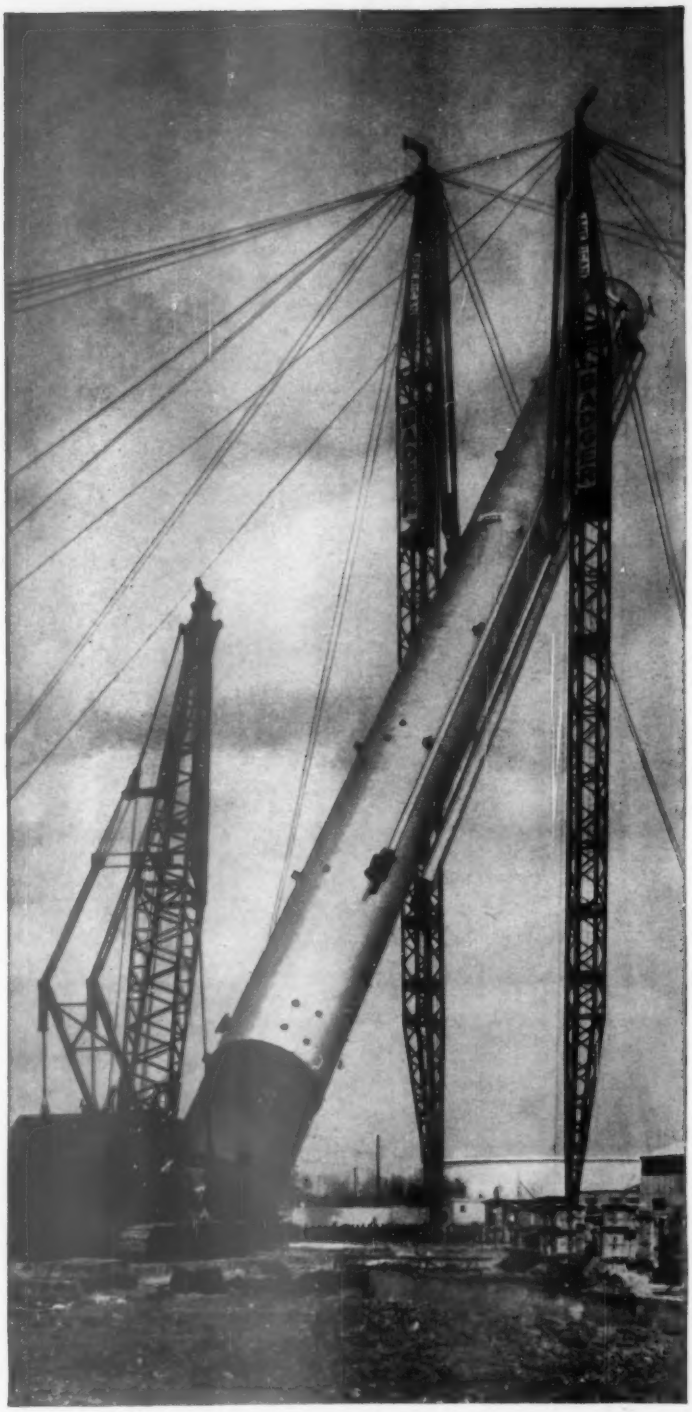
Ashland Oil & Refining Co.														
North Tonawanda	29,000	30,000	15,000	.....	[1]11,000	4,500	[15]7,500	[14]10,000	SR naph.	.....	[2]1,000	.....	.....	3,000
Mobil Oil Co.														
Brooklyn	30,500	33,900	7,600	.....	[2]15,300	8,100	.....	.....	.....	.....	[2]1,300	.....	.....	.....
Buffalo	30,000	31,500	12,400	.....	[2]13,200	7,100	[13]8,500	[13]8,500	SR naph.	[1]2,800	.....	.....	.....	3,600
Total	89,500	95,400	35,000	.....	39,500	19,700	16,000	18,500		2,800	2,300	.....	.....	6,600

North Dakota

American Oil Co. (formerly Standard Oil Co. of Indiana)														
Mandan	44,100	46,000	.....	.....	[1]18,000	7,000	[5]6,000	.....	.....	[2]1,800	[2]1,440	.....	.....	.....
Westland Oil Co.														
Williston	2,500	3,000	.....	[1]1,000	.....	.....	[1]700	.....	.....	.....	.....	.....	.....	.....
Total	46,600	49,000	.....	1,000	18,000	7,000	6,700	.....		1,800	1,440	.....	.....	.....

Ohio

American Bitumuls & Asphalt Co.														
Cincinnati	11,500	12,500	12,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9,400
Ashland Oil & Refining Co.														
Canton	34,000	35,000	20,000	[2]5,000	[1]12,000	5,000	[15]7,500	[14]10,000	SR naph.	.....	[2]1,200	.....	.....	3,600



A Big Lift for Sinclair Chemicals

The tallest distillation tower ever raised in one piece was lifted to its foundation in Houston, Texas recently. Coming along are five more like it. All will be part of a plant being built by Sinclair-Koppers Chemical Company to make styrene monomer, an ingredient of plastics and synthetic rubber.

In this joint undertaking with Koppers Company, Inc., *the Sinclair organization continues to expand its petrochemical operations.* Sinclair Refining Company will supply the basic raw material for the new plant. This raw material – ethylbenzene – will be made into styrene for use or sale by Koppers.

Sinclair has increased its petrochemical production and sales at a rapid rate in the past five years. It expects to maintain this pace with projects like the styrene plant and others being planned. *Chemical manufacture is the fastest growing part of Sinclair's business.*

The AIChE — Sinclair salutes the American Institute of Chemical Engineers for encouraging the advanced processing techniques which promote industrial progress. Founded in 1908, the institute — through its 20,450 members — advances chemical engineering standards, encourages original research, and fosters engineering education.

Sinclair

SINCLAIR OIL CORPORATION • 600 FIFTH AVENUE • NEW YORK 20, N. Y.

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking Fresh Feed	Catalytic Cracking Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
OHIO (Continued)														
Gulf Oil Corp.														
Cincinnati	35,317	37,000	7,000	[1]6,500	[1]13,300	5,700	[1]10,000	[1]7,500 [1]2,500	SR naph. Crkd. gaso.	.....	[2]1,500	.....	.....	2,600
Toledo	44,200	45,000	8,100	.....	[1]18,000	10,000	[1]10,000	.....	.....	[1]2,000	[2]1,580	.....	.....	.....
Midwest Refining Co.														
Weston	(See Sea-Way listing in table for plants not charging whole crude.)													
Pure Oil Co.														
Newark	20,000	NR	6,100	[1]6,400	[1]6,500	.....	[7]3,000	[11]3,000	SR naph.	.....	[2]450	.....	.....	.....
Toledo	38,000	NR	4,400	[1]5,100 [5]7,000	[1]11,600	7,400	[3]5,000	.....	.....	.....	[2]1,270	.....	150	.....
Standard Oil Co. (Ohio)														
Cleveland	52,000	55,000	18,000	[1]12,000	[2]23,000	12,000	[5]11,000	[15]11,000	SR naph.	[1]3,500	[2]1,000	1,600	.....	5,000
Lima	48,000	50,000	11,000	[5]11,000	[1]25,000	19,000	[1]12,000	[1]12,100 [1]1,000	SR naph. Mid. dist.	.....	[2]800	1,700	320	.....
Toledo	54,000	60,000	23,000	[5]7,500	[1]30,000	35,000	[7]12,000	[15]12,000 [15]10,500	SR naph. Other	[1]5,900	[2]2,350	.....	320	.....
Sun Oil Co.														
Toledo*	95,000	NR	.....	[3]17,000	[†3]62,000	.....	[1]14,700	.....	.....	[1]1,400	[3]3,000	.....	.....	.....
Total‡	432,017	455,555	110,100	79,390	208,290	94,100	86,835	69,600		12,955	13,485	3,300	790	20,600

*Stream-day figures not reported. All figures are calendar day. †Total feed. ‡State totals include calendar-day figures converted to stream-day basis. Cat cracking fresh feed total includes recycle when only total feed is reported.

Oklahoma

Allied Materials Corp.														
Stroud	3,230	3,400	2,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,000
Anderson-Prichard Oil Corp.														
Cyril	12,000	12,500	5,000	[1]1,900	[1]6,000	2,000	[6]1,000	*[1]1,000	.....	.....	[2]600	.....	.....	1,200
Bell Oil & Gas Co.														
Grandfield	7,200	8,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ben Franklin Refining Co.														
Ardmore	11,000	12,000	6,500	[1]2,000	[1]8,500	4,500	.....	.....	.....	[2]1,100	[2]250	.....	.....	2,200
Champlin Oil & Refining Co.														
Enid	31,680	33,000	19,700	[2]4,000	[1]13,270	6,635	[1]5,000	.....	.....	[2]1,936	[2]3,000	1,200	.....	1,500
Cities Service Petroleum Co.														
Ponca City	35,000	37,500	10,500	.....	[1]14,000	9,200	[9]6,000	.....	.....	.....	.....	.....	.....	.....
Continental Oil Co.														
Ponca City	72,000	78,000	13,000	[1]6,500 [5]16,500	[4]25,200	11,000	[1]5,100 [10]11,000	[14]16,000	SR naph.	[3]5,000	[2]750	2,250	510	.....
DX Sunray Oil Co.														
Duncan	44,000	45,000	16,000	[5]11,000	[1]25,000	12,500	[1]6,000	[1]6,000	SR naph.	[2]3,500	[2]750	.....	400	.....
Tulsa†	74,000	75,000	24,000	[5]8,500	[1]29,000	6,000	[1]19,500	[1]20,000	SR naph.	[1]2,300 [2]2,500	[2]2,000	6,500	300	.....
Kerr-McGee Industries, Inc.														
Cushing	21,500	22,000	3,900	[2]7,200	[1]7,600	3,200	‡[1]2,200	.....	.....	.....	[2]400	1,000	.....	400
Wynnewood	24,000	25,000	10,000	.....	[1]8,500	4,500	[1]5,500	[1]4,000 [1]5,500	Cat. feed SR naph.	.....	[2]600	.....	.....	2,750
Midland Cooperatives, Inc.														
Cushing	12,190	13,000	.....	[2]6,000	[1]5,300	3,700	[1]2,580	.....	.....	[2]1,330	§[2]450	.....	.....	.....
Phillips Petroleum Co.														
Okmulgee	19,000	NR	8,000	.....	[2]7,000	3,000	.....	.....	.....	.....	[2]700	.....	.....	475

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking Fresh Feed	Catalytic Cracking Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
OKLAHOMA (Continued)														
Texaco Inc.														
West Tulsa¶	40,000	NR	12,000	[1]9,000 [3]5,000	[1]18,000	.....	[1]8,000	[1]8,000	SR naph.	[2]2,300	[2]1,500	.....	.....	.....
Total‖	406,800	426,505	131,935	79,155	169,370	74,235	72,770	61,390		20,221	11,170	10,950	1,210	10,525
Oregon														
American Bitumuls & Asphalt Co.														
Portland (Willbridge)	6,400	7,000	7,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,500
Pennsylvania														
Atlantic Refining Co.														
Philadelphia	148,000	154,000	63,000	[2]16,000	[1]49,000	18,000	[6]29,000	[1]15,000	SR naph.	[5]5,700	[2]1,800	5,300	.....	7,500
Gulf Oil Corp.														
Philadelphia	182,000	192,000	82,000	[2]24,000 [3]8,000	[1]61,200	28,800	[1]68,000	[5]50,000 [16]52,000	Mid. dist. SR naph.	[1]6,800	[2]3,600	.....	.....	.....
Kendall Refining Co.														
Bradford	5,400	5,800	.....	.....	.....	.....	[1]1,500	[1]2,000	SR naph.	.....	.....	1,200	.....	.....
Pennsylvania Refining Co.														
Karns City	1,500	1,580	600	.....	.....	.....	.....	.....	.....	.....	.....	500	.....	.....
Pennzoil, South Penn Oil Co.														
Rouseville	10,000	10,400	.....	.....	[1]3,600	360	[1]2,900	[1]3,650	SR naph.	[2]1,100	[2]380	2,500	.....	.....
Quaker State Oil Refining Corp.														
Emlenton	2,540	3,000	1,500	[1]750 [3]600	.....	.....	[1]1,000	.....	.....	.....	[2]75	1,700	.....	.....
Farmers Valley	3,810	4,500	.....	[1]1,350	.....	.....	[1]1,500	.....	.....	.....	[2]100	2,300	.....	.....
Sinclair Refining Co.														
Marcus Hook	133,000	140,000	71,000	[1]5,000 [2]27,000	[1]40,000	8,000	[7]22,000	[10]22,000 [10]10,000	SR naph. Mid. dist.	.....	[2]1,850	.....	.....	.....
Sonneborn Chemical & Refining Corp., Amalie Refining Div.														
Franklin	1,550	1,800	.....	.....	.....	.....	.....	.....	.....	.....	.....	450	.....	.....
Sun Oil Co.														
Marcus Hook*	160,000	NR	.....	[2]14,600 [3]24,000	[†2]23,000 [†3]33,000 [†4]23,000	.....	[4]32,000	[14]15,000	Mid. dist.	[2]7,000	.....	11,800	.....	800
United Refining Co.														
Warren	15,000	15,600	4,500	.....	[1]6,000	2,100	[7]4,000	[1]5,500 [1]1,500	SR naph. Mid. dist.	[1]1,100	[2]350	.....	.....	1,000
Valvoline Oil Co., Div. of Ashland Oil & Refining Co.														
Freedom	5,500	6,000	2,000	.....	.....	.....	.....	.....	.....	.....	.....	800	.....	.....
Wolf's Head Oil Refining Co., Inc.														
Reno	2,150	2,350	.....	.....	.....	.....	.....	.....	.....	.....	.....	480	.....	.....
Total‡	670,450	705,450	224,600	125,585	247,575	57,260	165,455	178,315		22,475	8,155	28,340	.....	9,390

*Unit shut down. †2,400-bbl. butane isomerization unit. ‡Located at Cleveland, Okla. §Standby service only. ¶Stream-day figures not reported. All figures are calendar day. This plant includes 500-b.p.c.d. butane isomerization unit. ‖State totals include calendar-day figures converted to stream-day basis. Cat cracking recycle total includes the figures of one major company which are not reported in main table (with recycle estimated at 40% of fresh feed).

*Stream-day figures not reported. All figures are calendar day. †Total feed. ‡State totals include calendar-day figures converted to stream-day basis. Cat cracking fresh feed total includes recycle when only total feed is reported.

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking: Fresh Feed	Catalytic Cracking: Recycle	Catalytic Reforming	Hydrogen Treating: Unit	Hydrogen Treating: Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
Rhode Island														
Mobil Oil Co.														
East Providence	11,200	13,000	5,000											9,000
Texaco Inc.														
Providence (discontinuing operation in 1961)*	3,500	NR	1,750											1,500
Total†	14,700	16,685	6,840											10,670
South Carolina														
Humble Oil & Refining Co.														
Charleston	11,440	13,000	10,500											5,949
Tennessee														
Delta Refining Co.														
Memphis	19,500	20,000	5,000		[2]7,000	1,900				[2]1,200	[2]200			3,000
Texas														
American Oil Co.														
Texas City	148,000	160,000	33,000	[1]28,000 [2]14,000 [5]10,000 [9]9,800	[1]64,000	4,000	[5]42,000	[3]42,000	SR naph.	[1]9,000	[2]3,000		400	5,000
American Petrofina Co. of Texas														
Mount Pleasant	19,000	20,000	12,000		[2]6,200	3,800	[1]3,000			[2]1,500				5,200
Wichita Falls	9,000	10,000		[1]2,600	[1]2,800	800	[1]3,000				[2]250			
Anderson Refining Corp.														
Tucker	2,500	2,630		[1]1,200										
Atlantic Refining Co.														
Port Arthur	62,000	65,000	19,000		[1]21,700	9,300	[6]23,000	[1]15,000	SR naph.	[8][1]2,100	[8][2]150			
Bryson Pipeline & Refining Co.														
Bryson	2,000	2,105										100		
Cactus Petroleum Co., Inc.														
La Blanca	(See Permian Corp.)													
Col-Tex Refining Co.														
Colorado City	12,500	13,000	8,000	[1]3,700			[1]2,000	[1]2,800	SR naph.		[2]100			3,200
Continental Oil Co.														
Wichita Falls	11,800	13,500		[1]6,200			[1][6]3,500				[2]200			
Cosden Petroleum Corp.														
Big Spring	29,600	30,500	14,850	[1]5,000 [2]3,000	[1]14,000	3,000	[1]4,500 [9]5,500	[1]10,000	SR naph.	[2]4,000	[2]1,000			3,900
Crown Central Petroleum Corp.														
Houston	40,000	NR		[1]8,500	[2]12,000	4,000	[5]5,500	[6]5,500	SR naph.					
Danaho Refining Co.														
Pettus	11,400	12,000		[1]1,000			[1]1,000				[2]60			
Debco Corp. of Texas														
Abilene	700	850												
Delhi-Taylor Oil Corp.														
Corpus Christi	45,000	47,000		[2]2,400	[2]9,000	3,000	[1]19,000	[1]14,000 [1]2,300	SR naph. Other		[2]500			

*Stream-day figures not reported. All figures are calendar day. †State totals include calendar-day figures converted to stream-day basis.

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking: Fresh Feed	Catalytic Cracking: Recycle	Catalytic Reforming	Hydrogen Treating: Unit	Hydrogen Treating: Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
TEXAS (Continued)														
Port Isabel	12,000	14,300	.....	.....	.....	.....	[1]4,000	.....	.....	.....	.....	.....	.....	.....
Eastern States Petroleum & Chemical Corp.														
Houston	(See Signal Oil & Gas Co.)													
Eddy Refining Co.														
Houston	2,000	2,105	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
El Paso Natural Gas Products Co.														
Odessa	11,700	13,000	4,650	.....	[1]3,900	2,350	[2]2,600	.....	.....	[1]1,700	.....	.....	.....	.....
Flint Chemical Co.														
San Antonio	800	800	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gratex Corp.														
Graham	500	500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Great Western Producers, Inc.														
Irving	2,500	2,600	.....	.....	.....	.....	[7]1,000	.....	.....	.....	.....	.....	.....	.....
Gulf Oil Corp.														
Port Arthur†	269,040	284,000	129,500	[1]2,500 [2]23,500 [3]18,000	[1]102,000	23,000	[1]67,000	[5]50,000 [16]67,000	Mid. dist. SR naph.	[1]9,500	[2]6,000	13,000	.....	.....
Howell Refining Co.														
Corpus Christi	4,750	5,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
San Antonio	3,325	3,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Humble Oil & Refining Co.														
Baytown	292,300	309,000	169,500	.....	[1]146,400	28,600	[5]46,000	[2]18,000 [2]40,400 [2]17,300 [2]6,400	Hvy. crkd. naph. Mid. dist. Lube dist. Solv. dist.	[1]17,000	[2]5,700	23,600	.....	11,200
La Gloria Oil & Gas Co.														
Tyler	24,000	25,000	.. ..	[1]3,000 [5]8,500	[1]10,000	5,000	[1]5,000	.....	.....	[1]2,400	.....	.....	75	.....
Mobil Oil Co.														
Beaumont	220,000	237,000	35,000	[2]56,500	[2]80,000	20,000	[13]44,000	[13]44,000 [13]38,000	SR naph. Mid. dist.	[1]14,300	.....	7,300	.....	.....
Monarch Refining Co.														
San Antonio	4,000	4,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Permian Corp. (formerly Cactus Petroleum, Inc.)														
La Blanca	3,000	5,000	.....	.....	.....	.....	[6]750	.....	.....	.....	.....	.....	.....	.....
Petroleum Industries, Inc.														
Irving	1,000	1,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Petroleum Refining Co.														
Lueders	2,500	2,630	.....	[1]700	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Phillips Petroleum Co.														
Phillips	71,000	NR	17,000	[2]4,500	[1]38,000	2,000	[1]16,000	[14]10,000	Mid. dist.	[2]8,500	[2]750	.....	.....	.....
Sweeny	95,000	NR	17,000	.....	[1]24,000	6,000	[1]32,000	.....	.....	[2]5,500	.....	.....	.....	.....
Plymouth Oil Co., Republic Div. (formerly Republic Oil Refining Co.)														
Texas City	42,750	45,000	16,000	.....	[1]20,000	6,000	[1]7,500	.....	.....	[1]1,500	[2]1,800	.....	.....	.....
Pontiac Refining Corp.														
Corpus Christi	48,000	50,000	7,000	.....	[1]7,500	2,300	[1]13,000	[1]6,000	SR naph.	.....	[2]600	.....	.....	.....
Premier Oil Refining Co. of Texas, Div. of Western Natural Gas Co.														
Baird	2,900	3,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Brownsville	5,300	5,500	5,500	[1]1,200	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,600
Fort Worth	7,900	8,000	1,700	[6]2,200	[1]3,000	2,700	[1]1,700	.....	.....	.....	[2]290	.....	.....	.....

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking Fresh Feed	Catalytic Cracking Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
TEXAS (Continued)														
Longview	5,800	6,000	.....	[1]3,000	.....	.....	[1]1,500	[1]1,500	SR naph.	.....	[2]90	.....	.....	.....
Pure Oil Co.														
Nederland	80,000	NR	20,000	[1]10,500	[1]20,000 [2]17,100	7,500 2,900	[5]15,000	[15]20,000	SR naph.	[1]2,850	[2]825	2,000	.....	.....
Rado Refining Co.														
McAllen	1,425	1,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Republic Oil Refining Co.														
Texas City	(See Plymouth Oil Co.)													
Shamrock Oil & Gas Corp.														
Sunray†	25,000	26,500	10,500	.....	[2]7,000 [3]6,500	6,500 5,000	[1]2,200	[1]5,500 [1]1,500	SR naph. Mid. dist.	[1]4,500	.....	.....	.....	750
Shell Oil Co.														
Houston	128,000	132,000	60,400	[1]25,500	[1]48,000	8,000	[1]32,300	[7]25,000 [7]33,000 [7]6,500	SR naph. Mid. dist. Lube	[1]6,000	.....	5,700	.....	1,700
Signal Oil & Gas Co., Houston Div. (formerly Eastern States Petroleum & Chemical Corp.)														
Houston	63,000	65,000	25,000	[2]20,000	[1]20,000	3,400	[1]12,500	[1]17,000 [1]12,000 [1]6,000	SR naph. Mid. dist. Other	[1]4,000	.....	.....	.....	.....
Sinclair Refining Co.														
Corpus Christi	29,500	31,000	.....	.....	.....	.....	[7]7,500	[10]7,500	SR naph.	.....	.....	.....	.....	.....
Houston	159,000	167,000	43,000	[1]10,000 [2]14,000	[1]50,000 [2]10,000	20,000 1,000	[7]30,000	[10]30,000 [10]35,000	SR naph. Mid. dist.	[1]3,500	.....	4,850	.....	.....
Skelly Oil Co.														
Longview	4,500	5,000	.....	[1]3,300	.....	.....	[1]1,500	[1]400	SR naph.	.....	[2]100	.....	.....	.....
Southwestern Oil & Refining Co.														
Corpus Christi	33,000	37,000	9,000	.....	[1]8,700	2,500	[1]10,000	.....	.....	.....	[2]700	.....	.....	1,000
Standard Oil Co. of Texas														
El Paso	75,000	82,000	24,600	[9]9,000	[1]13,500 [3]11,000	13,500 4,000	[1]5,500	.....	.....	[1]1,600	[2]2,025	.....	.....	.....
Suntide Refining Co.														
Corpus Christi	52,250	55,000	12,000	[4]7,000	[1]19,000	13,000	[1]12,000	‡[1]6,000	SR naph.	[2]2,200	[2]500	.....	250	.....
Texaco Inc.														
Amarillo*	19,000	NR	.....	[1]2,000 [3]3,500	[1]8,000	.....	[1]4,500	[1]4,500	SR naph.	[1]800	[2]400	.....	100	.....
El Paso*	16,000	NR	.....	[1]2,000 [3]3,500	[1]7,000	.....	[1]3,500	[1]3,500	SR naph.	[1]1,500	[2]500	.....	100	.....
Port Arthur*	280,000	NR	100,000	[1]58,000 [3]17,500 [4]7,000	[1]120,000	.....	[1]60,000	[1]60,000	SR naph.	[1]13,800	[2]1,800	18,000	200	.....
Port Neches*	40,000	NR	22,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9,000
Texas City Refining, Inc.														
Texas City	34,000	35,000	11,500	[2]5,000	[3]17,650	350	[4]7,000	[6]7,000	SR naph.	[2]2,700	.....	.....	.....	.....
Texas Gas Corp.														
Winnie	7,600	8,000	.....	.....	.....	.....	[1]3,500	.....	.....	.....	.....	.....	.....	.....
Texstar Petroleum Co.														
Carrizo Springs	2,500	2,600	.....	[1]500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Three Rivers Refinery														
Three Rivers	1,500	1,500	500	.....	.....	.....	.....	.....	.....	.....	.....	750	.....	150
Tydal Co.														
Gainesville	2,000	2,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	200	.....	.....

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking Fresh Feed	Catalytic Cracking Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
TEXAS (Continued)														
Waskom Natural Gas Corp.														
Waskom	2,500	2,500	.....	.....	.....	.....	[7]1,000	.....	.....	.....	.....	.....	.....	.....
Wickett Refining Co.														
Wickett	3,500	3,685	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total§	2,584,840	2,735,530	834,622	427,690	962,950	273,500	569,605	678,155		122,475	27,656	77,500	1,165	45,700

*Stream-day figures not reported. Figures are calendar day. †4,900-bbl. pentane and higher isomerization unit at Gulf's Port Arthur plant, and 1,650-bbl. butane isomerization unit at Shamrock's Sunray, Tex., plant. ‡Unit throughput capacity reduced to 3,000 bbl. if charge contains 600 bbl. per day of coker naphtha, which is the typical operation. §State totals include calendar-day figures converted to stream-day basis. Cat cracking recycle total includes the figures of one major company which are not reported in main table (with recycle estimated at 40% of fresh feed).

Utah

American Oil Co. (formerly Utah Oil Refining Co.)														
Salt Lake City*	35,000	35,700	7,000	.....	[1]17,650	.....	[5]5,500	.....	.....	[1]5,000	[2]700	.....	.....	1,500
Beeline Refining Co. (formerly Western States Refining Co.)														
North Salt Lake City	6,900	7,500	.....	[1]1,500	.....	.....	[4]1,000	[6]1,000	SR naph.	.....	.....	.....	.....	.....
Petroflex Corp.														
Woods Cross (wax refining unit)	665	700	700	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Phillips Petroleum Co.														
Woods Cross	15,500	NR	3,000	.....	[2]5,500	4,500	[1]3,600	.....	.....	.....	[2]400	.....	.....	1,350
Salt Lake Refining Co.														
Salt Lake City	43,000	45,000	27,000	.....	[1]7,000 [3]8,000	2,000 5,000	[1]6,000	.....	.....	.....	.....	.....	.....	.....
Total†	101,065	105,215	37,700	1,500	38,150	11,500	16,100	1,000		5,000	1,100	.....	.....	2,850

*Includes 1,000-bbl. butane isomerization unit. †State crude-capacity totals include calendar-day figures converted to stream-day basis.

Virginia

American Oil Co.														
Yorktown	36,800	38,000	21,000	[5]14,000	[1]22,000	9,000	[5]7,600	[3]7,600 [3]15,000	SR naph. Mid. dist.	.....	[2]2,500	.....	700	.....

Washington

American Bitumuls & Asphalt Co.														
Richmond Beach	3,200	3,500	3,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,700
Mobil Oil Co.														
Ferndale	40,000	42,000	13,000	[2]6,600	[2]16,000	2,000	[13]9,000	[13]9,000 [13]6,000	SR naph. Mid. dist.	.....	[2]1,400	.....	.....	.....
Shell Oil Co.														
Anacortes	55,000	58,000	23,000	.....	[1]25,000	12,500	[1]7,000	[7]10,000	SR naph.	[1]3,800	[2]4,100	.....	.....	400
Texaco Inc.														
Anacortes*	45,000	NR	18,000	.....	[1]25,000	.....	[1]8,000	[4]20,000	SR naph.	[1]2,300	[2]1,100	.....	.....	.....
Union Oil Co. of California														
Edmonds	4,000	4,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,100
U. S. Oil & Refining Co.														
Tacoma	12,500	14,000	2,500	[1]2,000	.....	.....	[4]3,000	[6]3,000	SR naph.	.....	[2]100	.....	.....	2,000
Total†	159,700	169,370	60,950	8,600	68,775	25,610	27,890	50,220		6,355	6,820	.....	.....	8,200

*Stream-day figures not reported. All figures are calendar day. †State totals include calendar-day figures converted to stream-day basis. Cat cracking recycle total includes the figures of one major company which are not reported in main table (with recycle estimated at 40% of fresh feed).

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking Fresh Feed	Catalytic Cracking Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
West Virginia														
Elk Refining Co.														
Falling Rock	4,200	4,500	2,000	[1]800			[1]1,500	[1]2,000 [1]500	SR naph. Mid. dist.			1,000		
Quaker State Oil Refining Corp.														
St. Marys	2,371	2,800		[1]750 [3]600			[1]1,000				[2]75	600		
Total	6,571	7,300	2,000	2,150			2,500	2,500			75	1,600		
Wisconsin														
Empire Petroleum Co.														
Sheboygan	4,750	5,000	4,000											1,500
Murphy Corp. (formerly Lake Superior Refining Co.)														
Superior	12,500	15,000	2,000	[1]1,300			[1]3,100	[1]2,500 [1]2,500	SR naph. Mid. dist.					800
Total	17,250	20,000	6,000	1,300			3,100	5,000						2,300
Wyoming														
American Oil Co. (formerly Standard Oil Co. of Indiana)														
Casper	17,000	21,000	11,800	[1]4,800 [6]2,500	[1]8,900	600	[5]3,750	[3]5,000	SR naph.	[1]720		840	83	3,000
C & H Refinery														
Lusk	200	200												
Empire State Oil Co.														
Thermopolis	4,750	5,000												
Frontier Refining Co.														
Cheyenne	20,500	21,000	9,000	[1]1,000	[1]9,000	1,500	[1]2,500	[1]3,800 [1]2,400	Mid. dist. Burner fuel		[2]800			2,650
Husky Oil Co.														
Cody	8,100	9,000	4,500		[1]2,500	2,500	[6]1,000	[1]1,000	Mid. dist.	[2]650				3,500
Mobil Oil Co.														
Casper	13,000	14,000	5,000	[1]1,500	[2]5,250	5,250	[1][3]3,450	[1][3]4,700 [1][3]3,200	SR naph. Mid. dist.		[2]500			1,400
Sinclair Refining Co.														
Sinclair	24,000	26,000	9,000	[1]2,000 [3]2,000	[1]10,000	2,000				[1]1,870	[2]350			1,000
Sioux Oil Co.														
Newcastle	5,500	6,000		[1–2]3,000			[4]750				[2]80			
Texaco Inc.														
Casper*	17,000	NR	9,000	[5]4,000	[1]6,000		[1]4,000	[1]4,000 [4]4,000	SR naph. Gas oil		[2]500		100	1,500
Total†	110,050	120,095	48,775	21,245	42,315	14,515	15,895	28,990		3,240	2,285	840	193	13,220

*Stream-day figures not reported. All figures are calendar day. †State totals include calendar-day figures converted to stream-day basis. Cat cracking recycle total includes the figures of one major company which are not reported in main table (with recycle estimated at 40% of fresh feed).

Puerto Rico														
Caribbean Refining Co.														
San Juan	14,600	15,200	10,000		[1]8,500	2,400					[2]1,300			
Commonwealth Oil Refining Co., Inc.														
Guayanilla Bay	75,000	82,000	[1]68,996	[2]20,000	[3]26,500	26,800	[4]7,454	[1]7,500 [6]7,454	Mid. dist. SR naph.	[1]1,425	[2]1,605			
Total	89,600	97,200	78,996	20,000	35,000	29,200	7,454	14,954		1,425	2,905			

Report on Canadian Operating Refineries

Location and Capacities as of January 1, 1961*

Province	No. Plants	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking: Fresh Feed	Catalytic Cracking: Recycle	Catalytic Reforming	Hydrogen Treating	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
Alberta	11	95,820	102,105	29,305	19,860	22,955	2,000	21,045	20,635	2,775	335	2,220	65	10,075
British Columbia	7	99,475	105,085	45,050	5,500	33,100	16,400	18,255	32,305	1,750	5,610	.....	.....	6,890
Manitoba	3	34,330	36,225	12,755	1,375	12,480	3,680	6,700	5,700	720	510	.....	.....	1,220
New Brunswick	2	47,785	50,300	20,000	.....	13,000	5,500	7,000	14,000	.....	.....	.....	.....	3,000
Northwest Territories	1	1,500	1,580	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Nova Scotia	1	49,000	51,580	26,315	.....	18,890	.....	7,390	.....	.....	5,000	.....	.....	2,055
Ontario	7	263,320	280,565	94,295	17,555	84,885	25,780	48,855	55,975	3,000	1,990	4,775	165	7,155
Quebec	6	291,800	311,370	150,950	38,445	113,720	48,170	53,135	96,945	5,200	9,817	330	80	22,165
Saskatchewan	6	62,850	67,385	26,735	11,850	23,545	15,100	12,050	19,400	.....	3,610	.....	265	4,060
Yukon Territory	1	2,850	3,000	.....	.....	.....	.....	.....	.....	.....	.....	1,500	.....	1,500
Total	45	948,730	1,009,195	405,405	94,585	322,575	116,630	174,430	244,960	13,445	26,872	8,825	575	58,120

*For province totals, calendar-day figures reported by some companies were converted to stream-day basis.
Note: The legend for identifying types of processes is found at the beginning of the U. S. survey.

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking: Fresh Feed	Catalytic Cracking: Recycle	Catalytic Reforming	Hydrogen Treating: Unit	Hydrogen Treating: Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
Alberta														
Anglo American Exploration, Ltd.														
Hartell	3,800	4,000	.....	[1]1,350	.....	.....	[6]1,000	.....	.....	.....	[2]60	.....	.....	.....
British American Oil Co., Ltd.														
Calgary	9,000	10,000	2,500	[1]2,500	.....	.....	[7]3,000	[15]3,500	SR naph.	.....	.....	.....	.....	600
Edmonton	7,700	8,500	.....	[1]1,400 [5]2,100	[12]2,000	2,000	[6]5,400	[15]6,300	SR naph.	.....	.....	.....	65	.....
Canadian Husky Oil, Ltd.														
Lloydminster	5,170	5,500	2,100	.....	.....	.....	[19]400	[18]1,000	Mid. dist.	.....	.....	.....	.....	3,200
Canadian Kodiak Refineries, Ltd.														
Lloydminster	3,800	4,000	1,800	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,200
Canadian Oil Companies, Ltd.														
Innisfail	4,750	5,000	.....	.....	.....	.....	[1]1,850	[1]1,850	SR naph.	.....	.....	.....	.....	.....
Imperial Oil Ltd.														
Calgary*	14,700	NR	6,100	.....	[1]6,700	.....	[5]2,700	[2]2,700	SR naph.	[1]1,000	.....	.....	.....	1,000
Edmonton*	28,500	NR	13,000	[4]4,600	[1]8,200	.....	[5]2,000	[3]3,700	Lubes	[21]1,500	.....	2,000	.....	1,500
North Star Oil, Ltd.														
Grande Prairie	2,100	2,500	.....	[1]1,000	.....	.....	[7]875	[11]875	SR naph.	.....	.....	.....	.....	.....
Texaco Canada Ltd.														
Edmonton	12,000	NR	.....	[1]3,000 [5]2,200	[4]4,400	.....	[1]3,300	.....	.....	.....	[2]275	.....	.....	.....
Wainwright Producers & Refiners, Ltd.														
Wainwright	4,300	4,500	2,800	[1]1,200	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,300
Total†	95,820	102,105	29,305	19,860	22,955	2,000	21,045	20,635		2,775	335	2,220	65	10,075

*Stream-day figures not reported. All figures are calendar day. †Province totals include calendar-day figures converted to stream-day basis.

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking Fresh Feed	Catalytic Cracking Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
British Columbia														
British American Oil Co., Ltd. Port Moody	18,000	20,000	9,000	.....	[1]9,000	4,500	[7]4,000	[15]7,200 [18]4,000	SR naph. Mid. dist.	[11]1,050	.....	.....	.....	.....
Imperial Oil Ltd. Ioco*	32,000	NR	15,200	.....	[1]9,000	.....	[8]5,000	[2]5,000	SR naph.	.....	[2]2,340	.....	.....	1,370
Pacific Petroleums, Ltd. Taylor†	1,900	2,000	.....	.....	[1]1,700	.....	[12]2,000	[13]3,250	SR naph.	[2]700	.....	.....	.....	.....
Royalite Oil Co., Ltd. Kamloops	4,750	5,000	2,300	.....	[1]1,400	800	[1]1,000	.....	.....	.....	[2]110	.....	.....	820
Shell Oil Co. of Canada, Ltd. North Burnaby (Vancouver)	21,500	22,000	8,000	[12]2,000 [22]2,500	[16]6,000	7,100	[12]2,500	[12]2,500 [89]3,300	SR naph. Mid. dist.	.....	[2]400	.....	.....	2,000
Standard Oil Co. of B. C., Ltd. North Burnaby (Vancouver)	18,000	18,900	8,400	.....	[15]5,000	4,000	[12]2,700	.....	.....	.....	[2]2,500	.....	.....	2,200
X-L Refineries, Ltd. Dawson Creek	3,325	3,500	1,350	‡[11]1,000	.....	.....	[4]500	[6]500	SR naph.	.....	.....	.....	.....	350
Total§	99,475	105,085	45,050	5,500	33,100	16,400	18,255	32,305		1,750	5,610	.....	.....	6,890

*Stream-day figures not reported. All figures are calendar day. †Charges both crude and condensate. ‡Shut down. §Province totals include calendar-day figures converted to stream-day basis.

Manitoba

Anglo-Canadian Oils, Ltd. Brandon	2,630	3,000	.....	[11]1,375	.....	.....	[11]1,000	.....	.....	.....	[2]50	.....	.....	.....
Imperial Oil Ltd. Winnipeg*	18,500	NR	7,500	.....	[16]6,500	.....	[8]2,700	[2]2,700	SR naph.	[2]650	.....	.....	.....	1,100
North Star Oil, Ltd. St. Boniface	13,200	13,750	4,860	.....	[15]5,260	3,680	[12]2,700	[12]2,700	SR naph.	.....	[2]460	.....	.....	.....
Total†	34,330	36,225	12,755	1,375	12,480	3,680	6,700	5,700		720	510	.....	.....	1,220

*Stream-day figures not reported. All figures are calendar day. †Province totals include calendar-day figures converted to stream-day basis.

New Brunswick

Irving Refining, Ltd. St. John	47,500	50,000	20,000	.....	[13]13,000	5,500	[17]7,000	[17]7,000 [157]7,000	SR naph. Mid. dist.	.....	.....	.....	.....	3,000
New Brunswick Oilfields, Ltd. Weldon	285	300	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	47,785	50,300	20,000	.....	13,000	5,500	7,000	14,000		.....	.....	.....	.....	3,000

Northwest Territories

Imperial Oil Ltd. Norman Wells	1,500	NR	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Nova Scotia

Imperial Oil Ltd. Dartmouth (Halifax)*	49,000	NR	25,000	.....	[17]17,000	.....	[8]6,650	.....	.....	.....	[2]4,500	.....	.....	1,850

*Stream-day figures not reported. All figures are calendar day.

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking Fresh Feed	Catalytic Cracking Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
Ontario														
British American Oil Co., Ltd.														
Clarkson	55,400	61,500	28,000	[1]4,500	[1]18,000	11,700	[7]10,000	[15]12,000 [15]8,000	SR naph. Mid. dist.	[2]3,000	[2]1,260	1,220	.....	4,000
Canadian Husky Oil, Ltd.														
Fort William	3,570	3,800	1,300	.....	.....	.....	[6]1,000	[9]1,000	Mid. dist.	.....	.....	.....	.....	600
Canadian Oil Companies, Ltd.														
Corunna (Sarnia)	NR	50,000	20,000	[3]3,500	[1]16,000	7,000	[1]10,500	[1]5,000	Mid. dist.	.....	.....	.....	.....	.....
Cities Service Refining (Canada), Ltd.														
Bronte	18,850	20,000	8,200	.....	[1]6,420	7,080	[7]3,820	.....	.....	.....	.....	.....	.....	.....
Imperial Oil Ltd.														
Sarnia*	94,000	NR	26,500	.....	[1]22,000	.....	[8]13,500	[2]13,500 [2]4,600 [2]3,600 [2]600	SR naph. Lubes SR naph. Wax	.....	.....	3,200	150	2,300
Regent Refining (Canada), Ltd.														
Port Credit	26,000	NR	8,900	[2]6,000	[1]7,800	.....	[1]5,200	[4]5,200	SR naph.	.....	[2]730	.....	.....	.....
Sun Oil Co., Ltd.														
Sarnia*	18,000	NR	.....	[2]3,200	†[3]11,000	.....	[4]3,000	.....	.....	.....	.....	.....	.....	.....
Total‡	263,320	280,565	94,295	17,555	84,885	25,780	48,855	55,975		3,000	1,990	4,775	165	7,155

*Stream-day figures not reported. All figures are calendar day. †Total feed. ‡Province totals include calendar-day figures converted to stream-day basis. Cat cracking fresh feed total includes recycle when only total feed is reported.

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking Fresh Feed	Catalytic Cracking Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
Quebec														
BP Refinery Canada, Ltd.														
Ville d'Anjou (Montreal)	22,500	25,000	10,000	.....	[1]9,000	12,170	[1]6,000	[4]12,000	SR naph.	.....	[2]717	.....	.....	.....
British American Oil Co., Ltd.														
Montreal East	45,000	50,000	17,000	.....	[1]22,000	3,000	[6]13,000	[15]17,000	SR naph.	.....	[2]630	330	.....	9,000
Canadian Petrofina, Ltd.														
Pointe-aux-Trembles (Montreal)	30,000	32,000	15,000	[4]4,000	[3]14,000	5,000	[5]4,500	[5]5,000 [15]4,500	Mid. dist. SR naph.	[1]1,500	[2]400	.....	80	.....
Imperial Oil Ltd.														
Montreal East*	75,300	NR	40,800	[2]11,200	[1]20,900	.....	[8]8,400	[2]13,000	Mid. dist.	.....	[2]4,700	.....	.....	4,650
Shell Oil Co. of Canada, Ltd.														
Montreal East	60,000	63,000	33,000	[1]4,000 [2]5,000	[1]23,500	28,000	[1]8,300	[8]9,000 [8]22,000	Mid. dist. Naph. and mid. dist.	[2]1,500	[2]1,200	.....	.....	8,000
Texaco Canada Ltd.														
Montreal East	59,000	NR	33,000	[2]13,000	[1]22,000	.....	[1]12,000	[4]13,000	Mid. dist.	[1]2,200	[2]1,650	.....	.....	.....
Total†	291,800	311,370	150,950	38,445	113,720	48,170	53,135	96,945		5,200	9,817	330	80	22,165

*Stream-day figures not reported. All figures are calendar day. †Province totals includes calendar-day figures converted to stream-day basis.

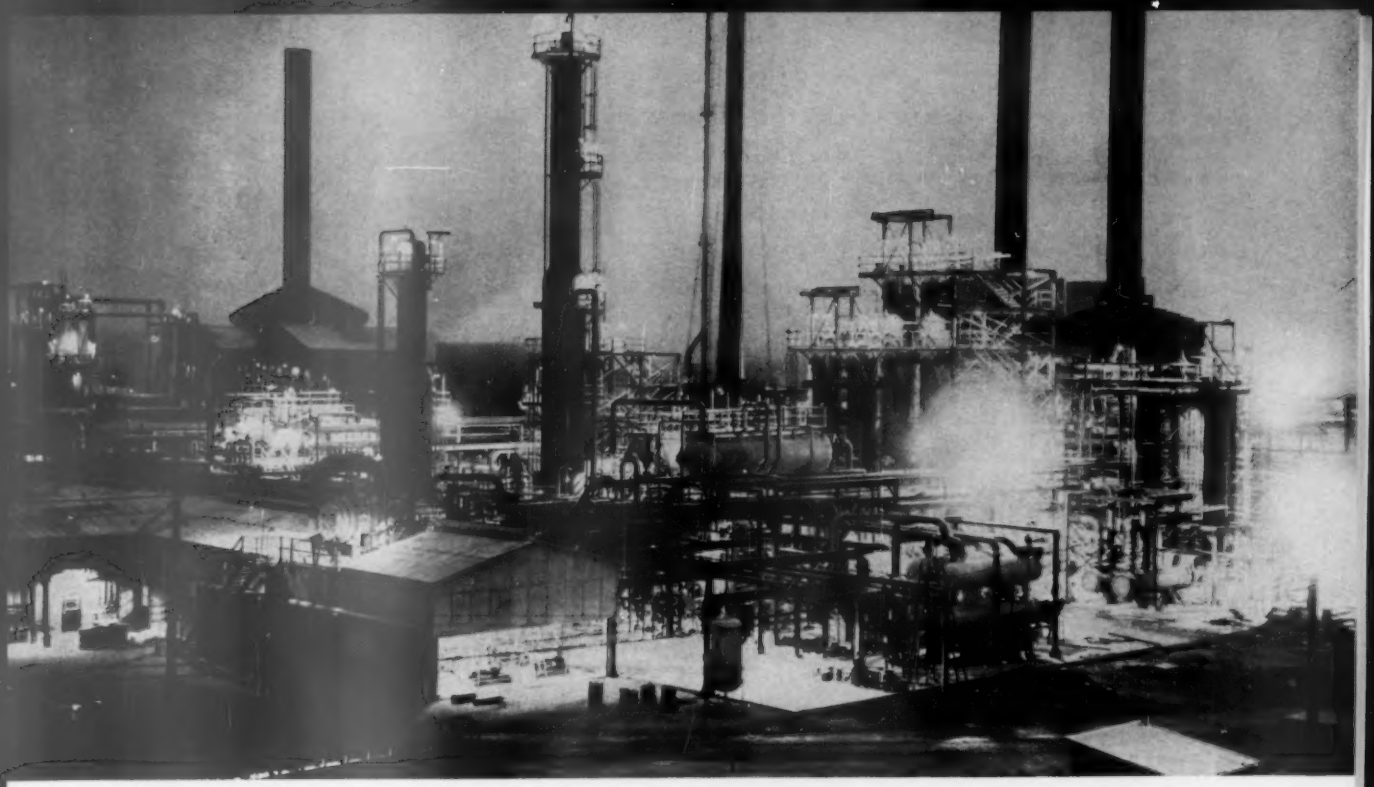
Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking Fresh Feed	Catalytic Cracking Recycle	Catalytic Reforming	Hydrogen Treating Unit	Hydrogen Treating Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
Saskatchewan														
British American Oil Co., Ltd.														
Moose Jaw	13,500	15,000	5,500	[1]1,500 [2]2,250	[1]4,500	5,500	[6]5,400	[15]6,400	SR naph.	.....	[2]390	.....	100	1,200
Canadian Husky Oil, Ltd.														
Moose Jaw	3,050	3,200	1,300	[2]1,300	.....	.....	[6]650	[9]1,000	Mid. dist.	.....	.....	.....	.....	800

Company and Location	Crude Capacity BPCD	Crude Capacity BPSD	Charge—Barrels per Stream Day: Vacuum Distillation	Thermal Operations	Catalytic Cracking: Fresh Feed	Catalytic Cracking: Recycle	Catalytic Reforming	Hydrogen Treating: Unit	Hydrogen Treating: Feed	Production—Barrels per Stream Day: Alkylation	Polymerization	Lubes	Coke (Tons)	Asphalt
SASKATCHEWAN (Continued)														
Consumers' Co-Operative Refineries, Ltd.														
Regina	15,200	16,000	6,500	[5]3,000	[1]7,000	7,000	[1]3,000	[1]3,000 [1]6,000	SR naph. Mid. dist.	.....	[2]750	.....	165	650
Imperial Oil Ltd.														
Regina*	22,500	NR	10,200	.....	[1]8,500	.....	[5]2,700	[2]2,700	SR naph.	.....	[2]2,000	.....	.....	550
Northern Petroleum Corp., Ltd.														
Kamsack	1,000	1,500	300	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	300
Royalite Hi-Way, Ltd.														
Saskatoon	7,600	8,000	2,400	[3]3,800	[1]2,600	2,600	.....	.....	.....	.....	[2]250	.....	.....	500
Total†	62,850	67,385	26,735	11,850	23,545	15,100	12,050	19,400		.....	3,610	.....	265	4,060
Yukon Territory														
Alaska-Yukon Refiners & Distributors, Ltd.														
Haines Junction	2,850	3,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,500	.....	1,500

*Stream-day figures not reported. All figures are calendar day. †Province totals includes calendar-day figures converted to stream-day basis.

Shutdown plants in the United States and Canada

Company and location—	Capacity b.p.s.d.
Alberta	
Bonnyville Oil & Refining Corp. (plant in Bonnyville sold in 1960)	1,000
California	
Superior Asphalt Co., Oxnard	1,500
Kentucky	
Aetna Oil Co., Div. Ashland Oil & Refining Co., Louisville	11,000
Louisiana	
Breaux Bridge Oil Refining Co. (plant at Lafayette sold to Otis Ainsworth for shipment to Sandersville, Miss.)	1,800
Clark Oil & Refining Corp., Marrero	7,000
Manitoba	
Radio Oil Refineries, Ltd., East Kildonana	500
Michigan	
Aurora Gasoline Co. (plant at Elsie dismantled for shipment to Genoa, Italy)	6,700
Nebraska	
Searle Petroleum Co., Salem	1,000
New Jersey	
Petroleum Separating Co., Bayonne	20,000
New Mexico	
El Paso Natural Gas Products Co., Bloomfield	1,000
El Paso Natural Gas Products Co., Brickland	4,200
El Paso Natural Gas Products Co., Prewitt	5,000
New York	
Gulf Oil Corp., Staten Island	18,500
Ohio	
Ashland Oil & Refining Co., Findlay	16,000
Western Reserve Refining Co., Div. Ashland Oil & Refining Co., Niles	6,000
Oklahoma	
Mercury Oil Refining Co., Oklahoma City	5,250
Wilcox Oil Co., Bristow	5,300
Saskatchewan	
Petroleum Fuels, Ltd., Moose Jaw	1,100
Royalite Oil Co., Ltd., Coleville	5,000
Royalite Oil Co., Ltd., Prince Albert	1,000
Tennessee	
Southern Oil Service, Nashville	800
Texas	
Cosden Petroleum Corp., Hawley	6,500
Gladewater Refining Co., Gladewater	2,500
Phoenix Refining Co., San Antonio	3,500
Sid Richardson Refining Co., (Texas City plant purchased by Texas City Refining, Inc.)	18,000
Texas Asphalt & Refining Co., Pasadena, Tex.	5,000
Wyoming	
Big D Oil Co., Sundance	125
Pilot Oil Co., Morton	500



JUST COMPLETED by Shell Oil Co. at Wood River, Ill., is this new Platformer, a part of a recent building program. Shell's new additions increase Platforming capacity by 25,000 bbl. daily and hydrotreating by 27,500 bbl. daily.

REFINERY CONSTRUCTION IN U. S. AND CANADA

New projects in the works at 50 refineries

THE LATEST refinery-construction report for the U. S. and Canada includes some upward adjustment in crude-charging capacity. But most of the work is being done in replacement of old facilities and new downstream units.

The new Journal survey actually shows 62 projects recently completed, under way, or planned. But about a dozen of these are long-range plans for new refineries, and construction hasn't actually been scheduled for them.

Of the 50 active projects, 46 are in the U. S. and 4 in Canada.

The firmed-up increases in crude-charging capacity will increase the U. S. total by about 120,000 bbl. daily. This includes Signal Oil & Gas Co.'s plans for a completely new refinery at Signal Hill, Calif., and the revamping of an old shutdown plant by Great Western Refining Co. at Dickinson, N. D.

Here is a complete list of current construction activity:

AMERICAN OIL CO., Casper, Wyo., will increase crude-charging capacity by 16,000 bbl. per stream day, with completion October 1, 1961. Present capacity is 21,000 bbl. Bechtel Corp., San Francisco, has contract.

At Mandan, N. D., American is adding a 7,500-bbl. per day Indiana Hydrofining unit, with completion June 1, 1961.

At Salt Lake City, American will add 4,000 bbl. per day cat cracking recycle capacity, with completion by staff September 30, 1961.

At Texas City, a new 150,000-bbl. crude unit will replace present units when completed September 1961. This will increase total capacity by only 5,000 bbl. per stream day to 165,000 bbl. The program will also boost vacuum capacity by 26,000 bbl. daily. Present capacity is 33,000. Scheduled for completion November 1961 is a 48,000-bbl. fluid cat cracking unit. Recycle will involve 47,000 bbl. per day. Contract for the above units is held by M. W. Kellogg Co., New York. In January 1962, a 14,500-bbl. sulfuric acid alkylation unit and a 7,200-bbl. C_4 isomerization unit will be completed by Fluor Corp., Ltd., Los Angeles.

At Whiting, Ind., 6,700 bbl. has been added to sulfuric acid alkylation capacity, with completion in February 1961 by Bechtel Corp.

ASHLAND OIL & REFINING CO., Catlettsburg, Ky., will complete work on 32,000-bbl. vacuum-distillation unit and a 12,000-bbl. cat reforming unit in May 1961. Contractor for the former is Badger Manufacturing Co., Cambridge, Mass., and for the latter, Blaw-Knox Co., Pittsburgh. Also scheduled for completion in May by Blaw-Knox is a 14,000-bbl. catalytic hydrogen-treating unit. Feed type will be naphtha.

AURORA GASOLINE CO., Detroit, has in the design stage the following units scheduled for completion spring 1962: 12,000-bbl. per calendar day Platformer, 2,500-bbl. distillate Unifiner, and an 18,000-bbl. naphtha Unifiner. Completion scheduled spring 1962.

BEN FRANKLIN REFINING CO., Ardmore, Okla., is increasing crude-charging capacity from present 12,000 bbl. per stream day to 25,000 bbl. Completion by Tears Engineers, Dallas, is scheduled September 1, 1961. Asphalt-producing capacity will be increased from present 2,200 to 3,000 bbl. per day.

CALUMET REFINING CO., Princeton, La., will complete a new 1,600-bbl. lube-finishing vacuum unit in May 1961, with own crews doing the work.

CANADIAN PETROFINA, LTD., Pointe-aux-Trembles (Quebec), will complete 2,500-bbl. asphalt-producing capacity April 1961, with staff handling the work.

CHAMPLIN OIL & REFINING CO.,

Enid, Okla., will complete a 4,000-bbl. per day delayed-coking unit in September 1961, with staff and Fluor Corp., Ltd., Los Angeles, doing the work. Coke-producing capacity will be 100 tons per day.

CHEMOIL CORP. plans to complete a new 40,000-bbl. refinery between New Orleans and Baton Rouge on the Mississippi River in 1963, with Lummus Co., New York, as contractor. Project will include 20,000-bbl. fluid cat cracker, 3,000-bbl. hydrofluoric acid alkylation unit, 1,200-bbl. catalytic polymerization unit, and 8,000-bbl. C_5 isomerization unit, as well as 5,000-bbl. basic asphalt producing capacity and 600-tons per day coke producing capacity.

CITIES SERVICE REFINING (CANADA), LTD., Bronte, Ont., is completing a 4,000-bbl. catalytic hydrogen-treating unit in April 1961, with Procon (Canada), Ltd., Toronto, contractor.

CONSUMERS' CO-OPERATIVE REFINERIES, LTD., Regina, Sask., will increase capacity from present 16,000 bbl. per day to 22,500 bbl. by November 1961. Fluid cat cracking capacity will be increased from present 7,000 to 16,000 bbl., with recycle to be increased from present 7,000 to 14,000 bbl.

CONTINENTAL OIL CO., Ponca City, Okla., will add 7,000 bbl. to its gas-oil cracking capacity by July 1, 1961, with the staff handling the job. Present gas-oil cracking capacity is 6,500 bbl.

CROWN CENTRAL PETROLEUM CORP., Houston, is expanding its cat reformer by 50%, or an additional 2,500 bbl. per day, with completion mid-1961.

DEBCO CORP. of TEXAS, Abilene, has increased capacity from 850 to 1,300 bbl. per stream day. Completion by company staff was in March 1961.

DOUGLAS OIL CO. OF CALIFORNIA, Santa Maria, has increased crude capacity from 3,500 to 4,000 bbl. per day, vacuum capacity from 2,800 to 3,200 bbl., and asphalt-producing capacity from 2,800 to 3,200 bbl. per day. Completion of the project was in February 1961.

DX SUNRAY OIL CO., Tulsa, is replacing old 75,000-bbl. crude unit with new unit of 85,000-bbl. per stream day capacity, with completion by Foster Wheeler Corp., New York, in September 1961.

FARMERS UNION CENTRAL EXCHANGE, Laurel, Mont., is boosting its crude-charging capacity from 20,000 to 28,000 bbl. per stream day and fresh-feed fluid cat cracking capacity from 8,000 to 12,000 bbl., with recycle increased from 1,000 to 6,000. Southwestern Engineering Co., Los Angeles, and company forces were scheduled to complete the project in April 1961. Installation of an alkylation unit may be considered later.

FLETCHER OIL CO., Wilmington, Calif., will add a 3,000-bbl. Platformer and a 3,000-bbl. Unifiner in 1961, with plant personnel handling the job. Feed stock for the Unifiner will be naphtha.

FLORIDA SOUTHERN OIL CO. (Frontier Refining Co.) plans to build a new refinery at Jacksonville, Fla. Plans and design for the plant have not as yet been finalized.

GLADIEUX REFINERY, INC., Fort Wayne, Ind., will increase capacity of its 2,300-bbl. crude charge by 700 bbl. per stream day, with completion September 15, 1961. Company forces to handle job.

GOLDEN BEAR OIL CO., Oildale, Calif., plans to add catalytic hydrogen-treating capacity of 1,000 bbl. per day, for lube feed stock, with completion in 1962.

GOLDEN EAGLE REFINING CO., Torrance, Calif., will replace existing crude-charging capacity of 9,000 bbl. per stream day with new 30,000-bbl. unit by January 1, 1963. The project will also include a 19,000-bbl. vacuum-distillation unit, 11,000-bbl. delayed-coking unit, 17,000-bbl. Platformer, 21,500-bbl. catalytic hydrocracking unit, and a 5,300-bbl. Unifiner. The coking unit will give coke-producing capacity of 460 tons per day. All units scheduled for completion January 1, 1963.

GREAT CANADIAN OIL SANDS, LTD., has reportedly had its application for a new synthetic crude-oil plant in Alberta's Mildred Lake tar-sand area deferred until 1962. The application was pending before the Alberta Oil and Gas Conservation Board.

GREAT WESTERN REFINING CO. is enlarging and revamping the old Queen City plant in Dickinson, N. D. The 4,000-bbl. crude unit will be on stream in July 1961, as will the 1,200-bbl. gas-oil cracking unit, and the 800-bbl. per day Platformer. The 1,500-bbl. vacuum unit will go on stream by September 1, 1961. Contractor is Litwin Engineering Co., Wichita, Kans. This will be the only asphalt-producing plant in the Dakotas.

GULF OIL CORP., Port Arthur, Tex., has added a 13,000-bbl. Gulfinishing unit for lube feed stock, with completion by Bechtel Corp. in March 1961. A 12,000-bbl. delayed-coking unit will be completed by M. W. Kellogg Co., New York, in July 1961. Coke-producing capacity will be 550 tons per day.

Gulf has long-term plans for a new refinery near Charleston, S. C.

HESS TRADING & TRANSPORT's new project at Sewaren, N. J., includes a 30,000-bbl. fluid cat cracker, a 15,000-bbl. Unifining unit, 40,000-bbl. vacuum unit, and 2,500-bbl. sulfuric acid alkylation unit.

HUMBLE OIL & REFINING CO., Baton Rouge, La., was to complete a 9,000-bbl. increase in fluid cat cracking capacity in April 1961, with company forces handling the job.

At Baytown, Tex., Humble's crude-charging capacity will be increased from present 309,000 to 319,600 bbl. per stream day in May 1961. Fluid cat cracking recycle capacity will be increased by 28,000 bbl. per day in May. Present recycle capacity is 28,600 bbl. Work is being handled by company forces.

At the Bayway refinery at Linden, N. J., visbreaking capacity is being increased from present 8,000 to 14,000 bbl. per day, with completion in April 1961.

MOBIL OIL CO., Beaumont, Tex., is adding a 20,000-bbl. per day delayed-coking unit, with completion by Lummus Co., New York, in June 1961. Coke-producing capacity will be 730 bbl. daily. In March 1961, sulfuric acid alkylation capacity was increased from 14,300 to 17,400 bbl. daily.

At East Chicago, Ind., a new crude topping heater will be completed first quarter 1962. It will add 2,000 bbl. daily to the existing 39,300-bbl. per stream day crude-charging capacity.

MURPHY CORP (formerly Lake Superior Refining Co.), Superior, Wis., plans to add a 5,000-bbl. fluid cat cracker, a 1,200-bbl. hydrofluoric acid alkylation unit, a 400-bbl. increase in distillate-fuel desulfurization capacity, and a 1,500-bbl. increase in gasoline-treating capacity. Construction will also include 200,000 bbl. of additional tankage and a new tetraethyl lead blending plant. Completion will probably be about January 1, 1962.

NAPH-SOL REFINING CO., Muskegon, Mich., will add 1,500 bbl. to existing 1,100-bbl. Platformer in summer 1961, with company forces handling the job.

NGL CORP. plans a 20,000-bbl. plant at Orange, Tex. for gas condensate and/or natural gasoline, with completion date indefinite. Facilities would include a 10,000-bbl. per day Platformer, 10,000-bbl. Unifiner, and 1,500-bbl. C_5 isomerization facilities.

OHIO OIL CO., Robinson, Ill., is adding 5,000 bbl. to present crude capacity of 50,000 bbl. per stream day, 1,805 bbl. to existing 18,050-bbl. vacuum capacity, 2,000 to existing 22,000-bbl. fluid cat cracking fresh-feed capacity, and 10,000 to present 8,000-bbl. cat cracker recycle capacity. Nooter Corp. has contract for the cat cracker job. Completion of the program is set for July 1, 1961.

PHILLIPS PETROLEUM CO., Phillips, (Borger), Tex., completed a 22,500-bbl. addition to its fluid cat cracking capacity first quarter 1961. Recycle was also increased by 2,500 bbl. per day. M. W. Kellogg Co., New York, had contract.

POWERINE OIL CORP., Santa Fe Springs, Calif., is building the industry's first Lomax catalytic hydrocracking unit, with capacity of 2,500 bbl. daily. Completion set for June 1, 1961. Also set for completion in June is a 2,500-bbl. addition to Platforming capacity. Company's own forces are doing construction.

RICHFIELD OIL CORP. has long-range plans for a $50-million refinery at Everett, Wash., with probable completion in 1965.

SHELL OIL CO., Martinez, Calif., has started work on a 5,000-bbl. hydrogen-treating unit.

At Wood River, Ill., Shell has added 25,000-bbl. capacity to the former 42,000-bbl. Platformer capacity. Hydrogen-treating capacity has been increased by 27,500 bbl. per day. Arthur G. McKee & Co. completed the construction in February 1961.

SHELL OIL CO. OF CANADA, LTD., is considering construction of a plant near Calgary, Alta., having taken option on a 310-acre site southeast of the city.

Shell of Canada also plans a 20,000-bbl. refinery at Bronte (near Toronto), Ont.

SIGNAL OIL & GAS CO. will build a new refinery at Signal Hill (Long Beach), Calif., with capacity of 20,000 to 25,000 bbl. daily. Design will permit expansion to 50,000 bbl. later. Construction scheduled to start first half 1961.

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SINCLAIR REFINING CO., Houston, is building a 60,000-bbl. crude-still replacement, with completion expected October 1961. A 7,600-bbl. catalytic hydrogen-treating unit will be completed in May 1961, and net increase in lube-producing capacity will be 400 bbl. per day by May 1. C. F. Braun & Co., Alhambra, Calif., has contract for the entire program

STANDARD OIL CO. OF CALIFORNIA, Western Operations, Inc., Honolulu, will add a 13,000-bbl. per calendar day fluid cat cracker in 1962, as well as a 3,800-bbl. sulfuric acid alkylation unit, and a 1,350-bbl. C_4 isomerization unit. Bechtel Corp., San Francisco, and Hawaiian Dredging have contracts for latter two facilities.

Long-range plans call for a 60,000-bbl. refinery near Everett, Wash.

STANDARD OIL CO. (OHIO), Toledo, is the first company to be granted license for California Research Corp.'s Isocracking process. The new 7,500-bbl. unit will go on stream November 1, 1961, with Ralph M. Parsons Co., Los Angeles, contractor.

SUN OIL CO. will build a gas plant to cost more than $9,000,000 at the Marcus Hook, Pa., refinery. It will replace two older ones. Products from the plant will be gasoline blending stock, fuel gas, alkylation and polymerization charge, and feed to the propylene splitter.

At Toledo, Sun is building a 10,500-bbl. propane deasphalter, with completion scheduled spring 1961. Foster Wheeler Corp., New York, is contractor.

SUN OIL CO., LTD., Sarnia, Ont., will complete a 2,600-bbl. per calendar day catalytic hydrogen-treating unit in May 1961. Contractor is Catalytic Construction of Canada, Ltd., Sarnia. Feed stock will be heating oils.

SUNSHINE STATE REFINERIES, INC., plans a new refinery in the Tampa, Fla., area. Capacity would be 25,000 bbl. daily. All processing details held up.

SUPERTEST PETROLEUM CORP., LTD., is considering a new refinery at London, Ont.

TENNECO OIL CO. will complete a 6,000-bbl. Houdriforming unit at Chalmette, La., in April 1961, with Bechtel Corp. contractor. A 7,000-bbl. catalytic hydrogen-treating unit will be complete late 1961. Feed type will be kerosine.

TEXACO INC., Port Arthur, Tex., is building a 12,000-bbl. kerosine Hydrotreater. Completion by Fluor Corp., Ltd., is scheduled mid-1961.

TIDEWATER OIL CO., Avon, Calif., will build the country's second Isocracking unit. Completion of the 20,000-bbl. per day unit is estimated for 1962.

The company, early in 1961, completed new fluid cat cracking facilities at the Delaware City refinery, boosting capacity by 4,000 bbl. daily.

UNION OIL CO. OF CALIFORNIA at its Los Angeles plant in Wilmington added another 20,000-bbl. to Unifining capacity in March 1961. Feed type is middle distillate.

Union has long-range plans for possible construction of a plant 33 miles north of Seattle, Wash.

THIS fractionating tower is part of Union Oil Co. of California's new 20,000-bbl. Unifiner at the Los Angeles refinery at Wilmington. It was completed in March 1961. Such downstream construction is typical of refinery building in recent months.

Plants not charging whole crude

American Gilsonite Co., Grand Junction, Colo.

Capacity: 6,050 bbl. per stream day for charging gilsonite. Facilities include 6,050 bbl. for delayed coking, 1,600 bbl. for Platforming, and 1,600 bbl. for hydrogen treating (feedstock coker naphtha). Coke producing capacity is 500 tons daily.

Bareco Wax Co. Division of Petrolite Corp., Kilgore, Tex.

Capacity: 750 bbl. per day charge capacity for tank bottoms and selected petroleum fractions.

Bareco Wax Co., Division of Petrolite Corp., Barnsdall, Okla.

Capacity: 1,100 bbl. per day for wax making.

Calstate Refining Co., Long Beach, Calif.

Capacity: Charges petroleum fractions to 2,600-bbl. visbreaker.

REPRINTS

The Journal's plant-by-plant refinery survey (starting on page 164) and an analysis in the news section of this issue will be available in reprint form at $2 per copy.

Place orders through The Oil and Gas Journal, Reader Service Department, Box 1260, Tulsa, Okla.

Calumet Refining Co., Burnham, Ill.

Capacity: Vacuum capacity is 750 bbl. daily. Lube-oil production capacity 750 bbl. per day. Crude unit shut down.

Cit-Con Oil Corp., Lake Charles, La.

Capacity: Charges 28,750 bbl. per day of petroleum fractions. Finished lube capacity is 10,000 bbl. daily.

Dallawax Co., Kilgore, Tex.

Capacity: 500 bbl. per day wax from tank bottoms.

Monarch Refineries, Inc., Oklahoma City.

Capacity: 2,000 bbl. per day asphalt.

Sea-Way Oil Refining Co. (formerly Midwest Refining Co.), Weston, Ohio.

Capacity: 500-bbl. per day plant to re-refine special oils, etc.

Ultra-Penn Refining Co., Division of Borne Chemical Co., Inc., Bruin, Pa.

Operation: This company blends lube oils and manufactures sulfonates.

Warwick Wax Division of Western Petrochemical Corp., Chanute, Kans.

Capacity: Makes wax from tank bottoms. 500 bbl. vacuum distillation, 350 bbl. propane deasphalting, and 200 bbl. wax percolation.

BY W. L. NELSON, Technical Editor and Petroleum Consultant

COSTimating

New cost indexes for instruments

THE TYPES of instruments published on the Itemized Cost Indexes page since 1949 have been replaced to some extent by more compact pneumatic instruments and by electronic instruments. Minneapolis-Honeywell Regulator Co., which has generously been supplying information throughout the years, has cooperated even more fully by surveying the general situation with respect to usage and by suggesting the new list of instruments, as well as the approximate number of each type of instrument that will probably be used during the next few years.

The relative weights and items used in the new composite instrument index (since October 1960) are:

Weight	Item
1	(1) PR (pneumatic)
1	(2) PR (electronic)
1	(3) PRC (pneumatic)
1	(4) PRC (electronic)
5	(6) PI Gage
4	(7) FR (Mechanical)
2	(8) FR (pneumatic)
2	(9) FR (electronic)
4	(12) FRC (pneumatic)
4	(13) FRC (electronic)
1	(14) TR (pneumatic)
1	(15) TR (electronic)
1	(16) TR potentiometer
1	(19) TRC (pneumatic)
1	(20) TRC (electronic)

Although six of the older instruments are still being retained on the Itemized Cost Index page, they are not included in the new composite index.

Cost Indexes of Insulation Materials

An index for high-temperature insulation materials is also now included among the itemized indexes. The new insulation index is supplied by the manufacturer (Johns-Manville) and it is a composite representing:

4 ft. 4 in. std. pipe covering
1 sq. ft. block, 2½ in. thick
1 sq. ft. blanket, 2 in. thick

On a price basis, the pipe covering represents about two-thirds of the total.

The prices published in Costimating No. 21 (OGJ, Nov. 19, 1956) were used as the 1946 basis for the new index as well as meager cost data supplied by the manufacturer for the years 1947 and 1958. Such a method was adopted because the types of materials used for insulation have constantly been changing and thus the new index represents the cost of obtaining insulation material for a job regardless of the type of material currently being manufactured. Indexes for the years between 1947 and 1958 can be approximated by noting the change in insulation cost index of the Bureau of Labor Statistics. This leads to the indexes shown in Table 1.

TABLE 1—APPROXIMATE COST INDEXES OF INSULATION MATERIALS

	Pipe covering	Blocks	Blankets	Composite
1946	100	100	100	100
1947	147.0	141.8	144.4	145.7
1948	157.8	152.2	155.2	156.4
1949	153.9	148.3	151.2	152.4
1950-52	....	....	....	....
1953	199.1	167.9	208.7	195.4
1954	202.2	170.3	211.8	198.5
1955	196.6	165.7	206.0	193.1
1956	187.2	157.9	196.0	183.8
1957	188.3	159.8	198.6	186.1
1958	191.3	161.3	200.6	188.0
1959	190.2	160.3	199.3	186.8
1960	192.0	161.8	201.4	188.5

Itemized Cost Indexes

The cost indexes may be used to convert prices at any date to prices at other dates by ratios of the cost indexes of the same date. Itemized indexes are published each quarter (first weekly issue of January, April, July, and October). In addition the Nelson Construction and Operating Cost Indexes are published in the first issue each month of The Oil and Gas Journal.

	1950	1954	1958	1959	1960	Nov. 1960	References*	Index for earlier years (The Oil and Gas Journal) in Costimating and Questions on Tech. issues
Operating costs (based on 1956 as 100.0):								
Power, electrical, industrial	97.3	98.5	102.8	103.2	104.8	105.4	Code 541-03	No. 13, May 19, 1958
Fuel, refinery	70.3	86.5	102.1	103.5	109.9	112.9		No. 4, Mar. 17, 1958
Gulf cargoes	78.0	85.9	102.9	93.5	101.8	107.5		No. 4, Mar. 17, 1958
N. Y. barges	76.9	82.6	93.0	85.9	91.2	94.9		No. 4, Mar. 17, 1958
S. Pedro bunkers	65.8	84.3	114.6	99.5	98.2	94.9		No. 4, Mar. 17, 1958
Oklahoma, northern shipments	77.7	62.0	66.3	78.8	83.7	88.7		No. 4, Mar. 17, 1958
Natural gas at wellhead	60.2	93.5	118.3	130.3	142.4	145.6	Code 531-01	No. 4, Mar. 17, 1958
Industrial chemicals	83.3	96.9	101.8	102.1	102.1	101.7	Code 61	No. 58, Oct. 12, 1959
Acid, phosphoric	86.7	96.6	103.4	103.4	103.4	103.4	Code 611-07	No. 58, Oct. 12, 1959
Acid, sulfuric	80.8	100.0	100.0	100.0	100.0	100.0	Code 611-09	No. 58, Oct. 12, 1959
Ammonia	104.8	103.0	103.8	105.1	108.1	111.3	Code 611-13	No. 58, Oct. 12, 1959
Lime	64.6	92.0	104.4	106.1	108.5	109.2	Code 611-29	No. 58, Oct. 12, 1959
Sodium carbonate	75.5	92.9	104.3	104.3	104.3	104.3	Code 611-65	No. 58, Oct. 12, 1959
Sodium hydroxide	76.3	90.9	112.6	115.7	115.7	115.7	Code 611-69	No. 58, Oct. 12, 1959
Sodium phosphate	87.5	95.5	104.6	104.6	104.0	101.2	Code 611-71	No. 58, Oct. 12, 1959
Furfural	79.0	100.0	100.0	100.0	98.6	95.8	Code 612-63	No. 58, Oct. 12, 1959
MEK, drums	80.0	94.5	106.9	103.3	103.3	103.3	Ch. & E. News	No. 58, Oct. 12, 1959

(Continued on next page)

Itemized Cost Indexes (continued)

	1950	1954	1958	1959	1960	Nov. 1960	References*	Index for earlier years (The Oil and Gas Journal) in Costimating and Questions on Tech. issues
Platinum	101.5	82.6	63.7	71.8	80.0	80.4	Code 1022-30	
Phenol	81.3	90.4	102.7	96.8	95.2	95.2	Code 612-83	No. 58, Oct. 12, 1959
TEL	94.1	102.8	99.9	100.7	97.7	97.7	Supplier	No. 58, Oct. 12, 1959
Operating labor (wages)	72.0	88.7	105.4	111.5	113.0	114.6	Employ. & Earn.	No. 41, Feb. 16, 1959
Productivity	85.5	97.1	100.3	109.0	112.9	113.2	Employ. & Earn.	No. 41, Feb. 16, 1959
Construction wages (1946 = 100):								
Skilled construction	140.0	174.6	205.1	214.6	223.5	227.5	Eng. News Record	No. 55, Nov. 3, 1949
Common labor	148.1	192.1	235.7	248.6	261.1	265.7	Eng. News Record	No. 55, Nov. 3, 1949
Refinery construction	144.0	183.3	220.4	231.6	241.9	245.1		No. 61, Dec. 15, 1949
Equipment or materials (1946 = 100):								
Arc-welding machinery		158.4	193.2	192.1	199.6	202.0	Code 1176	May 2, 1955†
Boilers, tanks and sheet metal	136.0	147.3	175.1	177.2	181.0	179.7	Code 1072	No. 5, Nov. 18, 1949
Building materials (nonmetallic)	127.0	143.6	161.7	163.5	164.0	163.8	Code 13	No. 61, Dec. 15, 1949
Brick—building	132.5	144.7	162.4	166.4	169.2	169.8	Code 1341	No. 20, Mar. 3, 1949
Brick—fireclay	153.4	193.1	238.7	244.4	244.4	244.7	Code 1342	May 30, 1955†
Castings (foundry products)	152.9	181.1	227.2	231.6	233.3	233.8	Code 1015	No. 46, Sept. 1, 1949
Clay products (structural, etc.)	134.6	159.1	187.0	191.4	193.0	193.6	Code 134	No. 20, Mar. 3, 1949
Concrete ingredients	125.3	142.1	163.2	164.7	167.8	166.8	Code 132	No. 22, Mar. 17, 1949
Concrete products	124.4	138.5	151.0	152.9	154.6	154.4	Code 133	
Electrical machinery	134.9	159.9	192.7	195.8	195.2	193.1	Code 117	May 2, 1955†
Motors and generators	135.0	157.7	186.4	186.4	182.8	180.2	Code 1173	No. 31, May 19, 1949
Switch gear		171.2	218.8	223.5	221.0	217.8	Code 1175	May 2, 1955†
Transformers	131.6	161.9	187.3	188.6	181.8	179.0	Code 1174	No. 31, May 19, 1949
Engines (composite)	126.0	150.5	178.3	178.5	180.7	180.0	Code 1154	No. 36, June 23, 1949
Exchangers	140.0	171.7	181.2	179.3	194.0	186.8	Manufacturer	No. 2, Oct. 28, 1948
Copper base		190.7	168.8	169.6	184.9	178.8	Manufacturer	
Steel		156.8	190.0	186.4	201.2	193.0	Manufacturer	
Fans and blowers	162.9	192.6	241.7	244.4	244.0	245.9	Code 1147	Feb. 17, 1949†
Hand tools	143.2	173.8	224.7	230.4	234.5	236.3	Code 1042	June 27, 1955†
Instruments (composite)	127.8	154.6	194.9	201.0	202.5	207.5	Manufacturer	No. 34, June 9, 1949
Pressure recorder (pneu.), PR	137.9	168.0	204.0	204.0	206.3	208.3	Manufacturer	No. 34, June 9, 1949
Pressure recorder (elect.), PR	137.0	162.8	229.5	246.6	243.0	245.7	Manufacturer	No. 34, June 9, 1949
Pressure recorder cont. (pneu.), PRC	134.0	163.5	198.8	198.7	201.7	203.0	Manufacturer	No. 34, June 9, 1949
Pressure recorder cont. (elect.), PRC	135.0	160.2	225.7	242.8	239.2	241.9	Manufacturer	No. 34, June 9, 1949
Pressure recorder cont. (stand.), PRC	135.6	166.3	200.0	200.0	204.7	207.1	Manufacturer	No. 34, June 9, 1949
Pressure gage only, PI	101.2	108.6	119.2	119.2	119.2	119.2	Manufacturer	No. 34, June 9, 1949
Flowmeter (mech.), FR	114.0	161.6	209.9	219.1	221.0	227.0	Manufacturer	No. 34, June 9, 1949
Flowmeter (pneu.), FR	113.8	161.4	209.6	218.8	220.7	226.7	Manufacturer	No. 34, June 9, 1949
Flowmeter (elect.), FR	136.8	162.3	228.5	245.6	242.0	244.9	Manufacturer	No. 34, June 9, 1949
Flow control (air), FRC	138.5	179.6	216.3	223.5	228.7	231.3	Manufacturer	No. 34, June 9, 1949
Flow control (remote), FRC	135.5	146.5	176.4	178.1	178.5	180.3	Manufacturer	No. 34, June 9, 1949
Flow control (pneu.), FRC	131.1	160.3	194.3	198.0	200.8	202.7	Manufacturer	No. 34, June 9, 1949
Flow control (elect.), FRC	134.0	159.1	224.1	241.1	237.4	240.1	Manufacturer	No. 34, June 9, 1949
Temp. recorder (pneu.), TR	128.3	157.3	188.1	188.1	190.6	192.6	Manufacturer	No. 34, June 9, 1949
Temp. recorder (elect.), TR	135.5	160.8	226.4	243.5	239.9	242.6	Manufacturer	No. 34, June 9, 1949
Potentiometer, 6-point, TR	134.0	167.2	240.4	258.9	240.9	240.9	Manufacturer	No. 34, June 9, 1949
Potentiometer (air con.), TRC	134.1	150.5	212.6	231.6	242.4	247.8	Manufacturer	No. 34, June 9, 1949
Thermometer recorder cont., TRC	124.0	152.8	179.7	179.7	183.9	186.0	Manufacturer	No. 34, June 9, 1949
Temp. control (pneu.), TRC	126.2	154.7	184.9	184.9	187.1	189.2	Manufacturer	No. 34, June 9, 1949
Temp. control (elect.), TRC	135.4	160.7	226.2	243.3	239.7	242.4	Manufacturer	No. 34, June 9, 1949
Control valve (pneu.)	133.3	162.0	199.3	199.3	199.3	199.3	Manufacturer	No. 34, June 9, 1949
Control valve (elect.)	133.3	161.9	199.2	199.2	199.2	199.2	Manufacturer	No. 34, June 9, 1949
Insulation (composite)		198.5	188.0	186.8	188.5	188.5	Manufacturer	
Lumber (composite)	193.0	197.8	198.9	214.1	204.8	194.1	Code 81	No. 7, Dec. 2, 1948
Southern Pine	176.9	181.2	184.7	190.9	187.9	181.4	Code 812	No. 7, Dec. 2, 1948
Redwood, all heart	212.0	238.0	204.0	218.5	211.4	202.9	Code 813-31	
Cypress, C select	250.0	253.0	266.5	267.5	267.4	267.6	Code 813-41	
Machinery:								
General purpose	136.7	159.9	199.6	206.0	208.4	207.4	Code 114	Feb. 17, 1949†
Construction	140.1	165.9	209.6	217.0	221.8	223.9	Code 112	
Oil field	135.8	161.9	192.5	192.6	193.0	192.6	Code 1151	Oct. 10, 1955†
Paints—prepared	140.0	159.0	180.9	179.9	181.2	181.0	Code 621	May 16, 1955†
Pipe:								
Sewer	120.7	140.1	170.1	176.2	178.2	179.5	Code 1345	No. 22, Mar. 17, 1949
Black iron	160.0	195.0	264.8	263.8	261.0	258.2	Code 1014-56	No. 42, Aug. 4, 1949
6-in. line	‡156.5	‡182.7	‡252.4	‡251.5	248.9	246.3	Code 1014-58	
Pumps, air compressors, etc.	138.2	166.5	214.7	226.5	228.3	228.8	Code 1141	No. 29, May 5, 1949
Steel (iron and steel)	152.9	179.6	228.2	232.4	229.7	227.6	Code 101	No. 61, Dec. 15, 1949
Steel—finished steel	153.7	187.1	240.6	244.7	244.0	243.7	Code 1014	July 25, 1955†
Plate		187.0	252.7	257.4	254.3	254.3	Code 1014-26	No. 5, Nov. 18, 1949
Structural shapes	162.7	193.4	262.8	268.5	268.3	268.3	Code 1014-31	No. 18, Feb. 17, 1949
Seamless tubes, 2-2¼ in.	149.5	199.4	277.5	285.1	282.7	282.7	Code 1014-61	Sept. 5, 1955†
Valves and fittings	135.8	197.1	242.7	257.6	260.3	250.7	Code 1149 (10 items)	No. 46, Sept. 1, 1949
Nelson Refinery Construction (1946)	146.2	179.8	213.9	222.1	228.2	229.6		No. 61, Dec. 15, 1949
Nelson Refinery Operation (1956)	72.4	88.7	105.8	106.8	108.8	110.0		No. 2, Mar. 3, 1958
Nelson Refinery Process Operation (1956)	75.1	88.4	105.8	106.0	107.2	108.5		No. 2, Mar. 3, 1958

*Code refers to the index code number of the Bureau of Labor Statistics, U. S. Department of Labor, "Wholesale Prices". †Questions on Technology, The Oil and Gas Journal. ‡Revised.

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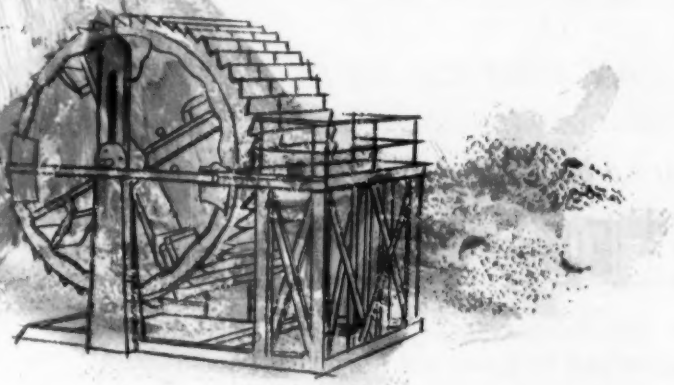

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THE PANEL

These panel members discussed refining problems at WPRA's El Dorado session: W. L. Banks, technical director of WPRA, Tulsa (panel moderator); F. W. Kopf, Atlantic Refining Co., Philadelphia; L. B. Parks, Continental Oil Co., Ponca City; D. P. Handke, Standard Oil Co. (Ohio), Cleveland; R. M. Brown, Union Oil Co. of California, Wilmington, Calif.; O. P. Doyle, Ingram Oil & Refining Co., Chalmette, La.; A. C. Patterson, Esso Research & Engineering Co., Linden, N. J.; T. J. Oleszko, Aurora Gasoline Co., Detroit; J. A. Gearhart, American Petrofina Co. of Texas, Mount Pleasant, Tex.; and J. A. Brooks, American Oil Co., Whiting, Ind.

PART 3

Refiners tackle cat cracking

at WPRA panel session

What are the problems associated with steam-generation coils located directly in an FCCU regenerator?

DOYLE: We do not have coils in our regenerator. We'd like to have them if only we had the room. They take up space and tend to increase regenerator velocities. If you are a little fellow and have a tight regenerator, this may be a real problem. It increases the tendency to get into poor air distribution in the regenerator, and, of course, you have more maintenance problems and erosion.

PATTERSON: I think I am right in saying that we also do not have any steam-regeneration coils in the dense bed of our fluid cat cracking units. However, we have had experience with steam-regenerating coils in other dense beds of fluidized solids, and I guess the principal problem we have encountered is leakage. This comes about through thermal fatigue.

If there is a liquid-water level in the tubes, surging occurs and the interface between steam and water moves up and down in the tubes. The tubes are subjected to rapid temperature changes because of the high head capacity of the liquid. Fatigue occurs, and the tubes break.

This can be corrected by a method that one of our engineers has patented, which involves making sure that you don't have very much liquid water in the tubes. The way you do this is to feed into the inlet header a mixture of about 90 wt. % of liquid water and 10 wt. % steam, both at roughly the same temperature.

What this does is to replace the liquid-water level with a thin film of liquid water which rapidly evaporates when it reaches the metal surface in contact with the fluid bed. The transition from a thin film of liquid water, which has very little heat capacity, into the steam phase doesn't subject the tubes to the thermal shock; therefore they last indefinitely.

BROOKS: We think the major problem when you have such tubes is thermal shock and failure from thermal shock. Our cat cracker people say that if water or steam is wetting the coils all the time, there is not much problem. However, if the system is allowed to alternate between wet and dry, thermal shock does cause these coils to crack. Thus, we believe the solution is to keep the coils wet at all times and minimize temperature fluctuations.

We have some information in our corrosion laboratory on the effect of carbon steel. We found that, with carbon steel, less than 75 temperature cycles will set up cracking in the steel. And these cracks seem to get deeper as the number of cycles is increased. However, cracking can be reduced by increasing the chrome content of the steel.

PATTERSON: I am not sure that I made my point clear. I did not mean that the tubes should be wet with water all the time. I don't know how you would control the amount of heat you remove from the fluid bed with steam generation, if you insisted on having the tubes full of water all the time.

L. G. BRANNIN (Cities Service Oil Co., Ponca City, Okla.): We are putting steam coils in our regenerator. This system is designed by Babcock & Wilcox Co. They put a similar system in one of the Sinclair plants about 7 or 8 years ago. We understand it has operated virtually trouble-free all these years. Actually it is a very simple system. There is a series of hairpin coils supported by hangers that go around the regenerator near the wall. The coils are made of Croloy 5, three-

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inch-diameter pipe. There is a steam drum and a pump that circulates a large amount of water through the coils, so that only a small amount of vaporization takes place on each pass.

R. G. ALEXANDER (International Refineries, Inc., Wrenshall, Minn.): Why do you want to put these steam coils in your regenerator? What sort of temperatures are you running, and what are you trying to achieve?

BRANNIN: We figure we can pay out these coils in 2 or 3 years just on fuel savings alone for steam generation. There is another problem, too, in that we have one of the early model Kellogg Orthoflow units which has a common head between the regenerator and reactor. Our regenerator runs around 1,160° to 1,175°. But in this particular design unit, enough spray water has to be used to keep the top of the regenerator at 1,100° F. for structural reasons. We add about 20-25 g.p.m. of spray water. We also have what we feel is a high catalyst usage—about 0.5 lb. per bbl. of fresh feed. We hope by running the regenerator bed at a lower temperature, by installing steam coils, and by minimizing spray water, we are going to get better catalyst activity and be able to reduce our catalyst cost.

BANKS: At partial capacity operation what factors maximize economics of FCCU operation?

BROWN: Our No. 1 objective is to maximize conversion. Quality and gasoline yield, as such, is of lesser significance to us. So, we would do everything possible to use the recycle which would tend to give us maximum conversion. In our par-

ticular environment we would maximize recycle and we would use the lightest recycle we could find.

DOYLE: We agree with increasing recycle. I think it depends on the reason for the reduced capacity. Is it a case of being short of feed stock or is it a case of some other requirement causing the cutback? In our area, gasoline-to-heating-oil prices are such that it is attractive to go for gasoline. We invariably find that the computer would prefer to take distillates into gas oil to make feed for the cat cracker, rather than go up in conversion at a reduced charge rate.

R. L. FLANDERS (California Research Corp., Richmond, Calif.): Can anyone on the panel tell me how to increase light-cycle-oil yield during periods of partial-capacity operation?

KOPF: The way to do that is to decrease your once-through, or total feed conversion, with a large amount of heavy-cycle-stock recycle.

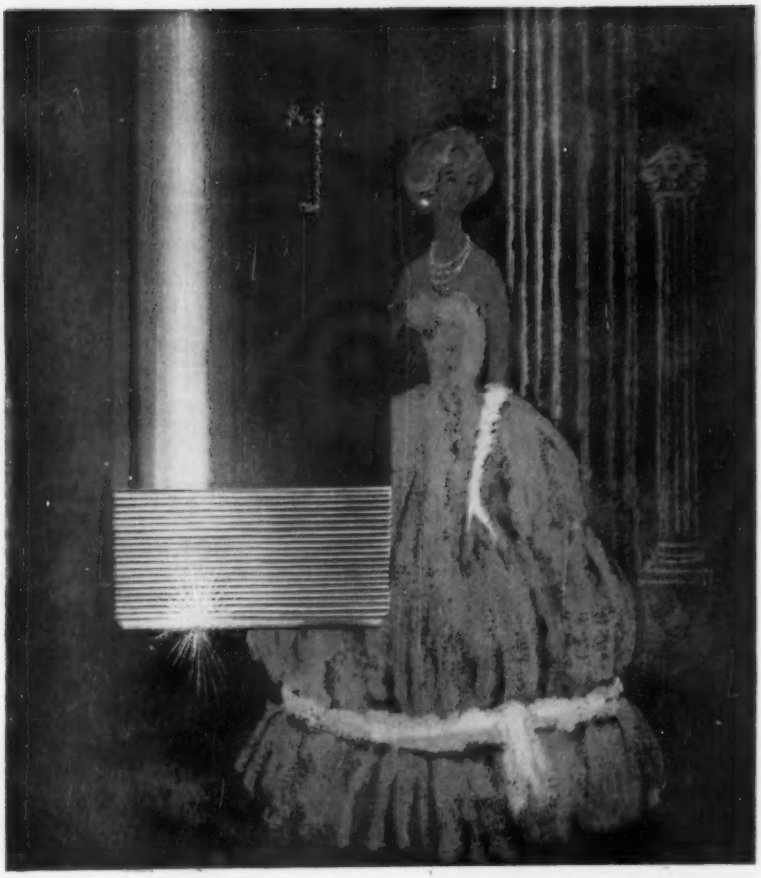
PARKS: Unless the distillate vs. crude price is such that you can afford to run additional crude to make marginal distillate, it would be economic, when running under capacity, to increase conversion on cracker and back out crude. That is, crack distillate to make your gasoline requirements. I agree with what has been said that the way to increase conversion is with recycle, since this generally results in better product distribution.

BROOKS: Our cat cracking people advise me that if the operations are below capacity on feed and cokeburn, we may consider several steps.

In the first place it may be possible to take in higher coke-forming components, or perhaps somewhat contaminated components, and attractively cat crack these. In a cokeburn-limited operation this would be unattractive.

Secondly, it may be attractive to make use of feed capacity to increase the recycle of heavy cat cycle oil, particularly if your operations are at high conversion.

Third, the concentration of oxy-



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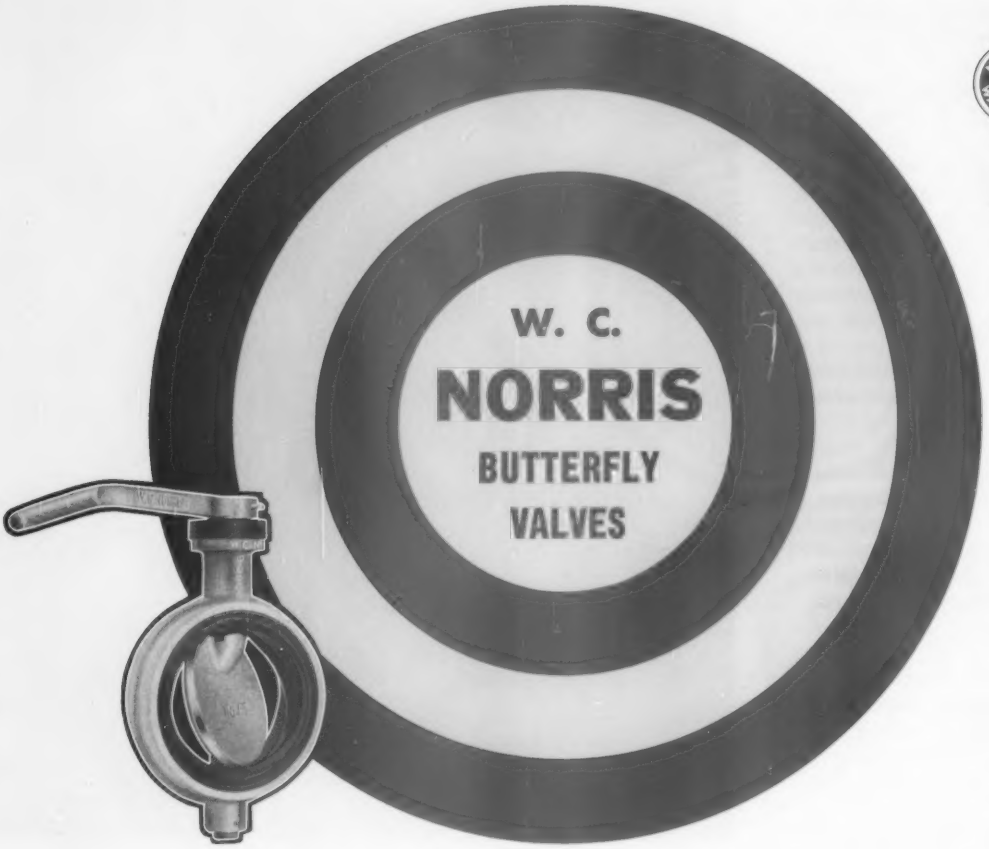

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gen in regeneration flue gas may be increased somewhat if your afterburn is not limiting. This will drive the carbon level down on the regenerated catalyst and our information says this gives you better yields from your cat cracker.

Finally, a flexibility may exist to readjust the reactor-bed level vs. reactor temperature to meet octane-yield requirements. Here, higher temperature and low bed level increase octane number and gas yield, but also decreases gasoline yield.

ALEXANDER: Our experience with reducing conversion is that the increased light-cycle oil is also higher pour point. This in turn limits the quantity of light-cycle oil which can be included in No. 2 fuel oil. If you are limited by pour point and the No. 2 price is right, the simplist way to increase light-cycle oil yield is to undercut the cat naphtha.

KOPF: I believe pour point would tend to go up. Of course, you are in a critical area on that score. On the other point, we have also practiced undercutting the back end of the cat naphtha under certain conditions.

PARKS: When you start talking about undercutting the cat gasoline and putting it into distillate, it seems to me you would have an unusual distillate-to-crude price relationship.

BROWN: We make a locomotive fuel that might be somewhat similar to the fuels you are talking about. And for years, in order to meet some specific TCC severity for a number of hours each day. When we looked more closely, we found that this was a disastrous operation. We were better off to dirty up a little virgin diesel and sell it at the lower return and come out way ahead just in terms of the gasoline make. Or I should say, gasoline loss, because of reduced severity on the TCC.

BANKS: On a fluid cat cracker, when increasing feed preheat from 600° to 700° F., holding conversion and recycle constant, is it necessary to increase reactor temperature due to the low catalyst circulation? If so, how much?

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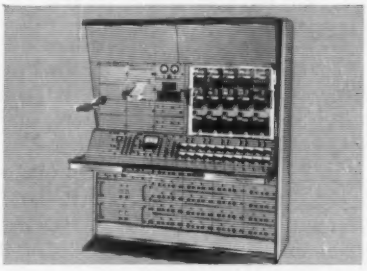

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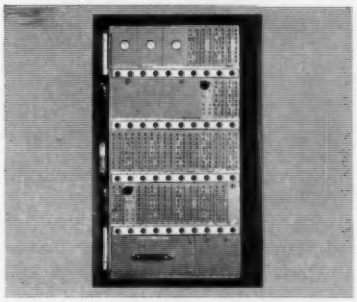

EAI Process Control Analog Computers feature solid state design, environmentalized housings and ruggedized construction to assure long-term reliability. Maintenance is simplified by modular construction, duplication of function packages, and built-in self-checking circuits.

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PATTERSON: Actually you don't have to increase reactor temperatures at all. You can hold the conversion constant at the lower catalyst-circulation rate by either increasing the amount of catalyst in the reactor, or by increasing the catalyst-addition rate. You thereby increase activity of the catalyst. If, however, you choose to increase temperature to hold conversion constant at the lower cat-oil ratio, while I haven't gone through the detailed calculations, I estimate it to be not more than 5°-10° F.

KOPF: There are several possible answers to the question because heat balance as well as conversion maintenance must be considered. The following hypothetical situations will illustrate some of the possibilities:

	Base	Case 1, constant reactor temp.	Case 2, constant regen. temp.
Preheat temp. °F	600	700	700
Feed rate, bbl. per day	32,100	32,500	34,500
Recycle, % of F.F.	50	50	50
Conversion, %	64.9	64.9	64.9
Reactor temp., °F	905	905	919
Regen. bed temp., °F.	1,143	1,156	1,143
Regen. outlet temp., °F.	1,110	1,110	1,110
Regen. spray water, g.p.m.	80	112	80
Air rate, M.c.f. per minute	95	95	95
Coke, % F.F.	9.35	9.29	8.70
Reactor catalyst, tons	150	170	149

In Case 1, if feed rate were held constant, an additional 15° F. in regenerator-bed temperature would be required. If there were no spray water used in the base case or Case 1, the feed rate would have increased to 33,800 in Case 1 and the regenerator dense and lean-phase temperatures would have risen by about 60° F. over the base.

W. K. DANIEL (Standard Oil Co. [Ohio], Cleveland): We've done some test work along these lines recently, and have come up with a relationship that it takes about 1° F. reactor temperature for 15° F. of fresh-feed preheat. This test work was done with an initial cat-to-oil ratio of about 6 to 1. With a higher initial cat-to-oil ratio, it probably would not have required as much reactor temperature increase.

PARKS: I've seen some data that would indicate about a 10°-15° F. increase in reactor temperature is required to hold conversion constant. Even though coke make for a given conversion would go down, I would expect regenerator temperature to rise, roughly the same number of degrees that you had to raise your reactor temperature. This would be due to lower heat removal from the regenerator with the feed. This could be a problem if you are at a regenerator limitation.

BANKS: What significant selectivity changes are encountered in high space velocity versus low space velocity, assuming conversion constant in the catalytic cracking units?

BROWN: About 3 years ago, when sensitivity started to squeeze us a little bit on gasoline, we thought we might try to reverse our objective and try out some lower reactor-temperature operations. To drop this reactor temperature we raised our bed level. We found that a 10 to 15-in. change was equivalent to about a 1° F. change in the reactor temperature. The effect wasn't nearly as great as we expected.

KOPF: We took a look at this question with our correlations in front of us. If you want to maintain conversion, you must do something to compensate for space velocity. In one case we increased the temperature to compensate. And in that case, certain products would go up and some would go down. So with a higher space velocity and an increased temperature, light gas would go up, C_3's and C_4's would go up; coke and gasoline would go down. The other alternate to get your conversion back is to up activity of the catalyst at the higher space velocity. In that case, gasoline would go up, and coke, gas, propylene, and butylene would go down.

T. B. KELLY (Pontiac Refining Co., Corpus Christi): We are at present putting about 8 tons per minute through a 20-in. o.d. riser, and we are considering going to a 30-in. o.d. riser, primarily to get alloy lining and a little more room to work in there. We'd be interested in anyone's comment as to what effect this might have on the process. The unit is limited right now on the blower. We'd like to leave conversion about the same.

DOYLE: I don't know the answer, but it sounds like a big change in riser. We circulate about the same rate in the 20-in. riser. I'd be a little cautious about going to 30-in. You might get quite a bit of slippage in there and it might defeat your purpose.

OLESZKO: We are contemplating increasing our riser to a larger one. We increased the riser in one of our units last spring and found it very attractive. It is under study at the present. It is certainly true that you have to hard-surface the inside against wear, whether you use hard surfacing or hexsteel and lining. I am not sure just which is the best at this point.

BRANNIN: We've also been considering this problem, and in working with Kellogg, the original designers of our unit, we've concluded there is no need to make a change in the riser unless we have excessive erosion. We would enlarge it then only the minimum amount to keep velocity in a reasonable range and control erosion. This erosion is primarily in the top few feet of the line. During our current shutdown, we are

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putting a tungsten-carbide-coated sleeve in the top of the riser which will extend down about 4 ft. through the area of most severe erosion. We are hopeful this will reduce erosion and eliminate the need for enlarging the line.

O. J. ZANDONA (Ashland Oil & Refining Co., Ashland, Ky.): We have recently changed the FCC-unit-riser-line size at the Louisville refinery from a 20-in to a 28-in. line. The plant went on stream recently and we did not have any difficulty with catalyst circulation. We have not noticed any change with respect to conversion or coke yield due to increase in riser cracking, which we anticipated.

DOYLE: I wanted to make a comment in regard to lining a portion of the riser. Where we have had experience with partial linings, we got into more or less "ratholing" behind the lining. The catalyst cut in behind the lining and eroded through the carbon steel in less time than would normally be expected if unlined. This experience was not in a riser, but it is something to look for.

BANKS: What feed inspections are being used in catalytic cracking correlations and to what degree of success?

KOPF: We use gravity and midboiling point for product distribution, with diesel index having a secondary effect. Carbon residue we consider important from the standpoint of coke - make. We also use a carbon-producing-factor test.

BROWN: We are in a transitional period in this model building. We have a model of our unit developed from regression analyses of some data which were easily available to us, both historically and easily obtained. The data included K factor and gravity. We have some generalizations built up from these inspections. The model is not adequate, and we are now starting to accumulate data so that in a few months we can start to develop correlations based upon more fundamental feed characteristics.

To give you just an example of how good our model is at the moment, we forecast all our operations weekly, unit to unit, in the refinery, on a min-max basis. Each unit is required to forecast daily, for a 6-week period, what it is going to make and what it is going to take. Our forecast on medium catalytic gasoline, as a specific example, is plus or minus 5%. We generally fall within that range. This gives you an idea what our model will do, and it isn't good enough.

FLANDERS: In trying to construct some kind of a model for coke production, we observe five significant items. The first is catalytic cracking itself. The second is metals which contribute to coke. The third is asphaltenes which can be represented by Ramsbottom or Conradson carbon. The fourth is chemisorbed materials, such as nitrogen compounds, which tend to be chemisorbed on the catalyst and contribute to the coke make. The fifth is occluded material which is a function of stripper efficiency.

GEARHART: May I add that a fifth important factor, especially at higher concentrations, is the sulfur content of the feed stock.

BANKS: In cat cracking does coker gas oil give lower octanes than virgin gas oils?

BROWN: Our correlations tell us that an incremental coker gas oil should give a higher octane. However, this is because the coker-gas-oil increment is lighter than the average feed.

BROOKS: When you operate at the same severity, you get the same octane from coker gas oil that you do from virgin gas oil. The virgin and coker were basically from the same crude source, which may be important.

HANDKE: I'll have to go along with John Brooks. Our pilot-plant data shows that, on delayed coker gas oil with the same midboiling point, octane is the same.

FLANDERS: In our laboratory studies of coker gas oil, we found the most important single factor was boiling range of the feed. Some coker gas oils tend to be low boiling; but as long as they are gasoline-free, high-octane gasoline can be made from them. Heavier boiling materials, whether coker or virgin, tend to make lower octanes. It has been our experience that the boiling range of coker and virgin gas oils have to be the same before comparisons of this type can be made.

BROOKS: If you make this comparison on the same midpoint, what do you get? More or less, or the same octane?

FLANDERS: I recall one example with California stocks. In that particular case, we had roughly identical octanes from the two types of stock at the same feed 50% temperature.

BANKS: Has anyone information on adding fluid catalyst to the riser with raw oil? Does it reduce losses?

HANDKE: We have been doing this for about 6 years, but have only done a limited amount of test work on it. What we have done hasn't shown any reduced losses.

PATTERSON: We haven't done this. We would think that it would have a marginal advantage—it would get you at least one pass through the reactor zone with the fresh catalyst fines before they were lost from the unit. With good recovery equipment, this is bound to be marginal because you'll recover most of the fines. If your fresh catalyst has fine catalyst that your recovery equipment won't handle, and you add it to the reactor or the inlet into the reactor, you run the risk of overloading recovery equipment on the reactor

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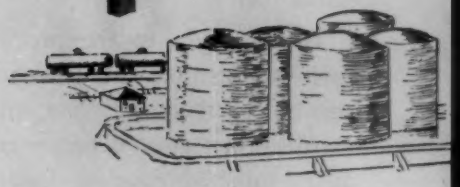

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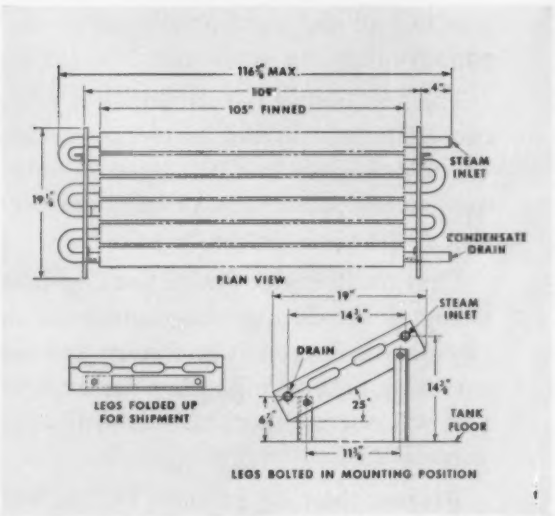

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WHAT REFINERS SHOULD EXPECT FROM ANTIKNOCK SUPPLIERS... NOW, AND IN THE FUTURE

Today's gasoline is a mixture of many hydrocarbons and it is also a blend of many important decisions on the part of the refiner.

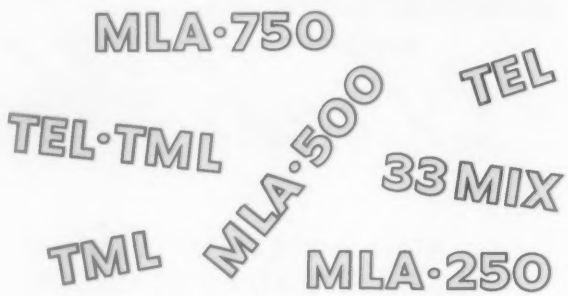
One important decision today is how to bring into agreement four factors—fuel composition, car population requirements, the best antiknock for a specific fuel and marketing objectives—to produce the most satisfactory and most profitable fuel.

The solution to the problem of matching fuel composition and antiknock is a complex one but, at the same time, one that can be rewarding in terms of better road performance at the same or less cost. Essentially it involves the optimum allocation of components and the blending of the right antiknock in the right concentration.

The selection of the antiknock is vital for it can contribute to the correction of an antiknock deficiency in a fuel, such as unsatisfactory motor octane and/or road performance, and at the same time reduce costs.

Changes in engine design and engine size are changing the octane requirement of the car population. Especially do foreign and compact cars have their own peculiar demands for fuel that will operate them satisfactorily at an economical cost.

Because there are so many factors that must be taken into consideration, the problem becomes quite complex. It is here that the antiknock supplier should be in a position to help in arriving at the best possible solution. That is why Ethyl is now even more actively engaged than ever in a program that will enable us to assist refiners in finding their own individual answers to: "Which antiknock—*exactly*."



No single antiknock enough

In prior years, changes in fuels and fuel-engine relationships were met satisfactorily by changes in the formulation of the one antiknock compound universally used by the oil industry.

Today, however, because the hydrocarbon composition of components varies from company to company—and even between refineries in a single company—no one antiknock can any longer be best for the whole industry or even for a single company. Therefore, to meet

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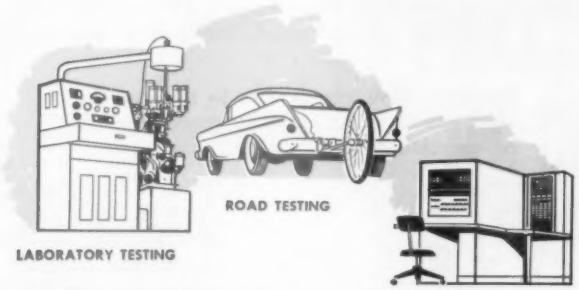
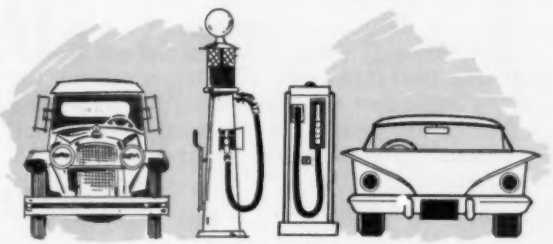
the industry's needs, Ethyl is now offering a number of antiknock compounds.



Ethyl takes action

To assist refiners in the selection of the antiknocks best suited to their needs, Ethyl has broadened its long-term program of matching fuels and antiknocks. A number of antiknocks, and combinations of antiknocks, are being tested in hundreds of gasoline blends from many refiners. These tests are for both laboratory and road rating and will be related to cost effectiveness. This project will produce a wealth of timely information for the individual refiner.

From this information it will be possible to make precise selection of an antiknock to insure optimum processing balance and minimum refining costs. In addition, an antiknock thus selected might well supply a refiner with an exclusive and promotable benefit that can be invaluable in the marketing function.



No substitute for experience

Long experience in the technology of antiknocks is necessary for the development of new antiknocks and their manufacture. Knowledge of the manufacture of one antiknock does not necessarily mean the knowledge required for the manufacture of another. While there may be surface similarities, there are often significant differences.

It is also experience that is the necessary ingredient in holding costs down. The successful, economical production of a finished product results from a complete know-how of the many processes involved and their economical operation.

Ethyl, with its 37 years' experience in this field, feels that it is especially suited to be of invaluable assistance to any refiner, regardless of size, who is facing the problem of: "Which antiknock for *us!*"

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side. We haven't done it, and this is the reason we haven't.

DOYLE: Cities Service reported in The Oil & Gas Journal a year or 2 years ago that they had tried this and if I remember right, they had plugging troubles and found that their catalyst losses went up.

W. E. McFATTER (Cities Service Refining Corp., Lake Charles, La.): The article Paul Doyle refers to was published in The Oil & Gas Journal, September 27, 1954. We tried this at Cities Service at Lake Charles and our stack losses did increase. We attributed it to the fact that the high-activity catalyst made the first pass through the reactor and built a higher coke level than on the equilibrium catalyst, because we found that the fines leaving the stacks had a higher carbon level when the catalyst was being added directly. We abandoned the system and didn't use it anymore.

BRANNIN: At Ponca City we have added catalyst directly to the reactor in the past. The catalyst was slurried with either fresh feed or heavy gas oil and then pumped continuously through a 1-in. line into the reactor about 1 ft. above grid. The program was discontinued because it made no apparent difference in catalyst losses or unit operation.

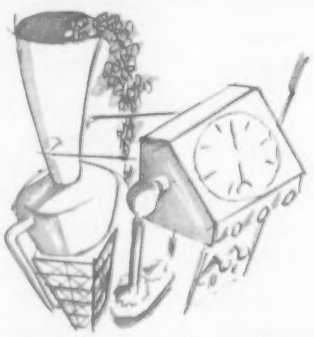
BANKS: What information is available concerning slurry injection directly to the reactor above the catalyst bed?

KOPF: Before slurry settlers were installed, the slurry used to be returned directly to the dense phase of the reactor. At that time, and I think it was in 1945, we ran for about 4 to 5 months with the slurry return to the top of the lean phase. It was done through a 1-in. pipe pinched down to a narrow opening on the end. With a ⅛-in. opening, in 5 days of operation, gravity on the slurry oil changed from 10.5° to 7.5° API. At this point the operators got worried because there was no sign of any slackening. With this operation, Δ t between the lean phase and the dense phase increased from 10° to 30° F., indicating that all the slurry was being vaporized. The obvious intent here was to drop the catalyst back and get the oil out without cracking. Then they upped the size of the opening on the end of this fish tail to 3/16-in. at which point the Δ t leveled off to about 15° F. Gravity then stayed at 7.5° API for the next 4 months. That operation resulted in about a 0.2% reduction in coke yield on the unit. At the end of this time the unit was shut down for a turnaround. Inspection revealed that the top section of the reactor was heavily coked up on the cyclone, hopper walls, etc. There was an estimated 10 tons of coke removed, the hard way, from the top of the reactor, and we did not do this again.

PARKS: Indications are that when we inject slurry onto the bed rather than in the riser we got a slight reduction in coke. However, the data are not conclusive. The line from the settler to the bed tends to plug, so there is frequent switching back and forth from the riser to the bed. This gives operators a good opportunity to note the effect, but the results do not clearly favor reactor injection.

G. D. BORTHICK (Bay Petroleum Co., Denver): Last winter a line was installed to carry slurry recycle to the top of the reactor. We run as high as 10 vol. % on feed through the line and have not had any trouble doing so. The unit has been inspected once since installation, and we did not find a great deal of coke near the inlet nozzle. I should emphasize the inlet location is approximately 15 ft. above the reactor grid. We do not have firm data to verify our thinking, but we feel we have derived some benefit from this type operation.

BANKS: Have any devices to measure catalyst stack losses been successfully used commercially?



KOPF: Some while ago we had a continuous catalyst-measuring device on the stack of one unit. This was developed and put in at a time when we were having considerable difficulty with the Cottrells and it was felt that this instrument would aid in solving the Cottrell problem. The instrument consisted of a tube to measure the gas flow rate, an electric-eye system to measure density of the catalyst in grains per cubic foot, and a mechanical integration system to express the results in pounds per unit time on a recorder in the control room. A windshield-wiper arrangement on the glass was needed to keep it clean, so that the electric eye could get a good view of the catalyst concentration. We have subsequently taken this out of service.

BROWN: We have air-pollution requirements in Los Angeles that require us to watch particulate matter. We have used API methods 756-54 and 755-54 as described in the API Manual on "Disposal of Refinery Wastes."

BROOKS: I just want to make reference to a system for recording catalyst losses continuously. The system is described by Ramser & Hicky in Industrial Engineering Chemistry, Vol. 41, 1949. We do not have any experience or information beyond that indicated in the article.

BANKS: Is high recycle rate beneficial on relatively low-boiling gas-oil feed stocks?

BROWN: We can report a test run on 22.3° API, 700° F., 50% point feed. We went to high and low

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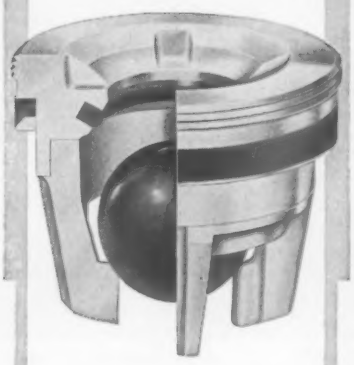

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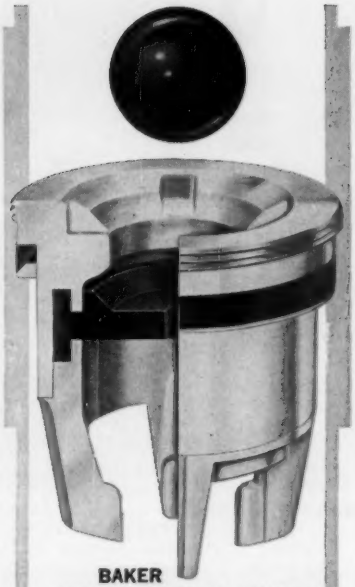

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recycle rates with everything else controlled. We got a higher conversion by about 1.25% at the high recycle rate. Our normal recycle is about 0.1 and high for us would be about 0.3%.

KOPF: Using high recycle rates on relatively low-boiling gas-oil feed, there would be a lower coke production, less total-feed conversion; and, with low bed-level operation, would result in lower gasoline-to-furnace-oil yields. If that is the direction that is desired, it would be beneficial.

HANDKE: Well, I would be in the middle by the way I'm going to answer the question. Our general philosophy is that no matter what kind of feed stock we have, we're going to run as high a recycle ratio as we can. We feel that the higher recycle rates maximize gasoline, minimize gas. And we feel we get a better isobutane-to-butylene ratio, which in our instance is quite critical.

BANKS: What portion of the catalytic distillates are being hydrogenated and reformed?

BROWN: We have for some time now been Unifining and reforming as much of our catalytic gasoline as we had room for in our present reformer, largely because of the olefin control in southern California. But we have to go further. By the end of the year we will be Unifining and reforming all catalytic distillate above C_6 to 380° F., and Unifining the 380° F. to 440° F. e.p. material.

L. P. EVANS (Mobil Oil Co., Paulsboro, N. J.): It might be of interest to the group here to know that our Torrance refinery on the West Coast just 2 months ago put into operation a hydrotreater especially designed to treat both catalytic and thermally cracked gasoline stocks to meet this alleged air-pollution regulation. They are currently charging the light thermal and light TCC gasolines. Total feed to the unit is about 50 bromine number and it is being taken down to about 2 or 3 bromine number which is adequate to meet the current restrictions. This operation is a mild hydrogenation at about 400 psig. with hydrogen cascaded over from the reformer, and at a relatively low temperature of about 600° F.

BROOKS: How much virgin is in the mixture?

EVANS: There is no virgin stock in this feed.

BROOKS: The reason I asked is that there is a tendency when you hydrogenate all cracked materials to get a temperature rise and this is sometimes uncontrollable unless you have some virgin stock in the charge.

EVANS: This is not unusual with stocks high in bromine number, that's right. With the feed stock I mentioned Torrance is getting about a 200° F. temperature rise, but this is not uncontrollable.

RAY PARKER (Rock Island Refining Co., Indianapolis): This same operation occurs where a 100% stock is Hydrotreated. There is, however, a loss in octane—about 2 RON.

BROWN: The stock we're Unifining by itself is a 350° to 450° F. heavy cat stock. We're hydrogenating the material by itself quite satisfactorily and controllably.

BANKS: Has anyone ever correlated per cent hydrogen on coke with any variable other than per cent stripping steam? Feed gravity? Feed aniline point?

PATTERSON: We have found that hydrogen in coke does correlate with per cent stripping steam all right, but it is also increased as catalyst circulation rate increases and carbon on regenerated catalyst increases. Increasing temperature decreases hydrogen on coke. We don't know about feed gravity, but I would expect that a higher-boiling feed stock would tend in this direction, because it would be more tightly absorbed on the catalyst. We don't have a correlation to say this. This is just intuition. We would also expect that more aromatic feeds would give you a higher hydrogen on coke. Again, because the aromatics are tightly absorbed and would, therefore, more likely reach the regenerator without being stripped from the catalyst.

BANKS: How does reactor temperature affect motor octane number?

DOYLE: There is an article by Olsen and Sterba of UOP published in November 1949, in Chemical Engineering Progress. This covered the effect of reactor temperature changes fairly thoroughly. The numbers they showed were that the clear motor octane number increased less than two numbers while going from 850° to 950° F. reactor temperature. The leaded motor number showed no change at all at these two different levels. In the research they had an increase of 3.0 clear octane numbers and the leaded octane number increased one number going from 850° to 900° F. But it did not increase going from 900° to 950° F.

KOPF: We use 0.1 octane number motor method clear per 10° F. increase in temperature. It is less than the research octane number effect.

BROWN: Our correlation seems to indicate a 0.03 increase in leaded motor octane with each 0.75° F. change in reactor temperature.

Tips on selecting prime movers

By JOSEPH ZABA

DECIDING whether an internal-combustion engine or an electric motor is to be used to drive a beam-pumping installation involves a number of factors. No general statement can be made on the use of one of the two types of power because (1) there are so many factors which have to be considered and (2) the available data on costs hold true usually only for a specific set of conditions. Generalization could lead to error.

When considering engines, the future availability of gas is important—conversion to electric power in later life of the field could be uneconomical. Cost of installing and maintaining the gas-gathering system must be included. And is the gas sweet or sour?

Fifteen or twenty years ago the cost of gas was only a minor factor and frequently was not even included into consideration. Now, however, gas is valuable and the present and future cost of gas must be included in comparative calculations.

As far as electric power is concerned the cost of bringing the power to the producing leases and distributing it to the individual wells, the cost of maintaining the distribution system, the cost of power and the terms of the contract must all be considered. If a private generating plant is considered, the investment and the operating cost (fuel), future increase in power demand because of increase in volume of produced water, probable life of the field, and spacing of wells should be the factors controlling the selection.

Looking at the prime mover itself, the original investment, cost of operation and maintenance, efficiency of converting energy into power, availability of trained field personnel, and availability of repair facilities all have to be weighed against each other.

Future well conditions, particularly the volume of the fluid to be lifted, must be considered because of the trend toward water flooding as a means of secondary recovery.

Sizing of prime movers. Because of load characteristics of the pumping cycle, certain derating factors are applied to prime movers when calculating the power requirements at the prime-mover sheave shaft. These factors are different for different types of prime movers as discussed later. In one specific case, an additional factor must be used in calculating power requirements, regardless of the type of prime mover.

In Part 10 of this series it was stated that prime-mover power requirements can be calculated from polished-rod horsepower by assuming efficiency of the unit at 80%, provided the unit is not severely underloaded. But if only a small part of the unit's capacity is used, the polished-rod power requirements become only a fraction of the total power requirements which include power needed to overcome internal friction of the unit. This could happen where expectations of large volumes of fluid did not materialize and a large unit is being used for a small job. A similar problem may exist in very deep pumping, where polished-rod horsepower may be small, but a large unit must be used to handle the rods and counterbalance loads.

For determining the losses across the pumping unit we use the ratio of polished-rod horsepower to the unit's nominal horsepower. The latter may be determined from the formula:

$$HP_U = T/4{,}960 \qquad (1)$$

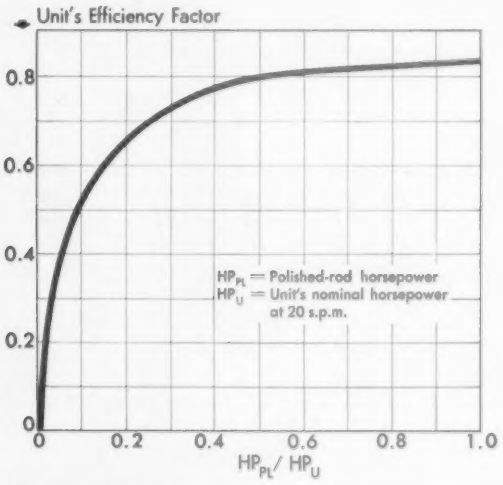
Where:

HP_U = unit's nominal horsepower at 20 s..p.m.

T = API peak torque rating of the unit

For any given ratio of the polished-rod horsepower to the unit's nominal horsepower the efficiency factor of the unit may be found from Fig. 47. Note that for ratios of less than 0.50 this factor drops off rapidly.

To illustrate the use of the efficiency factor let's assume that the well conditions are such that an API 320 pumping unit will be used and the polished-rod horsepower has been calculated to be 12 hp. The unit's nominal horsepower at 20 s.p.m. would then be 320,000/4,960 = 64.5 hp., Equation 1. The ratio of horsepower at polished rod to the unit's horsepower would be 12/64.5 = 0.186. From Fig. 47 the efficiency factor is 0.64. Therefore, power needed at the prime-mover shaft would be 12/0.64 = 18.75 or 19 hp. in round figures.



EFFICIENCY FACTOR of pumping unit for any given ratio of polished-rod horsepower to unit's nominal horsepower may be found on this chart. Fig. 47.

Engine standards. API Standard 7B-11C, Sixth Edition, March 1956, "API Specification for Internal-Combustion Engines and Unit-Type Radiator Coolers for Oil-Field Service" gives definitions of the items of equipment and the concepts involved, outlines the test procedures required, and presents information to be furnished by the manufacturer, if requested by the purchaser.

A "bare engine" is defined as an engine less all accessories except those (built in or attached) absolutely required for running. A "power unit" is an engine complete with all accessories, except muffler, supplied or

recommended by the manufacturer. "Maximum standard brake horsepower" at any rotational speed is the greatest horsepower, corrected to standard conditions of 60° F. and 29.92 in. Hg, which can be sustained continuously under conditions of the prescribed test. Torque at any speed corresponding to the maximum standard brake horsepower at this speed is the "maximum standard torque."

Factors for approximate conversion of standard brake horsepower for altitude and temperature conditions under which the prime mover is expected to operate are also given in the standard. Standard brake horsepower should be reduced by 3% for each 1,000 ft. elevation above sea level. However, some engines do not require this exact deduction and information should be obtained from the manufacturer. Brake horsepower should be reduced or increased 1% for each 10° rise above or drop below 60° F., respectively. Older API Standards contained the concept of "API horsepower" defined as 65% of the maximum brake horsepower. This concept has been dropped from the new standard. However, many users are still applying this derating factor for certain engines in oil-well pumping as discussed in the next installment.

Information to be furnished by the manufacturer, on request, includes recommended maximum and minimum speeds for continuous operation, maximum speed for intermittent operations, maximum standard brake-horsepower curves for type of service intended, within recommended speed range, and maximum torque curves and fuel consumption curves for minimum, intermediate, and maximum speeds.

BOOKS

POLYSTYRENE. By William C. Teach and George C. Kiessling. Published by Reinhold Publishing Corp., 430 Park Avenue, New York City 22. 176 pp. $5.

Major emphasis throughout this book is on the applications of polystyrene by injection molding, by extrusion, by vacuum forming, and as a foam. Without delving deeply into the theoretical aspects of polymer chemistry, the authors present well-organized but short chapters on the properties and basic chemistry of polystyrene which should serve well to introduce this plastic to those with a rudimentary knowledge of chemistry.

The chapter on manufacture, fabricating techniques, and various uses of expandable polystyrene describes primarily methods of manufacture used abroad, with no mention of the continuous mass, or plate and frame methods that are widely used in the U. S.

The book contains a large amount of material of interest to research workers, such as a new approach to the evaluation of the effects of polymerization temperature on molecular weight, and new information on the copolymerization of styrene and alpha-methylstyrene.

INDEPENDENT IRAQ: 1932-1958. By Majid Khadduri. Published by Oxford University Press, 417 Fifth Avenue, New York City 16. 388 pp. $7.20.

An Iraqi writer in this book attempts to give the inside story of contemporary political development in his country.

The narrative covers the period from the termination of the Mandate to the middle of 1958—it gives the details of political strife among the parties and political groupings after Faysal's death, the intervention of the army in politics, and the military coup d'etat which culminated in the Rashid Ali coup and the clash with Great Britain in 1941.

Developments leading to the collapse of the former regime have been dealt with in detail, in particular the coups d'etat of 1948 and 1952. At the end of the book a new chapter has been added dealing with the Development Board, the 1952 oil agreement, the Communist movement, and the causes of the breakdown of democratic government.

TABLES FOR PETROLEUM GAS-OXYGEN FLAMES. By I. I. Berenblut and Anne B. Downes. Published by Oxford University Press, 417 Fifth Avenue, New York 16. 107 pp. $4.80.

This book presents tables of the combustion products and their thermodynamic properties over a wide range of temperatures of a selection of liquefied petroleum gases-oxygen flames. These tables will help workers studying heat transmission from LPG-oxygen flames insofar as the applications of rich LPG-oxygen flames are limited by the maximum temperatures attainable and also, secondarily, by the composition of their combustion products at different temperatures.

Note: The Oil and Gas Journal maintains a book department. Write to the READER SERVICE DEPARTMENT, P. O. Box 1260, Tulsa 1, for copies of the book list. Often this source.

Nelson Refinery Cost Indexes

Published in the first issue each month in the Technology-Operation Section.

Compiled by W. L. Nelson, Technical Editor and petroleum refinery consultant, Tulsa.

Charts of the indexes are published each year in a late January or early February issue.

Indexes of selected individual items of equipment and materials are also published on the Costimating page in the first issue of the months of January, April, July, and October.

Refinery Construction Cost Index (1946 Basis)

Explained on page 101 of the issue of August 5, 1957.

	1950	1954	1957	1958	1959	Nov. 1960
Pumps, compressors, etc.	138.2	166.5	206.7	214.7	226.5	228.8
Electrical machinery	134.9	160.0	188.9	192.7	195.8	193.1
Internal-combustion engines	126.0	150.5	173.9	178.3	178.5	180.0
Instruments	127.8	154.6	187.4	194.9	201.0	207.5
Heat exchangers	140.0	171.1	203.6	181.2	178.9	186.8
Miscellaneous equipment average	*126.2	160.7	192.1	192.4	196.1	199.2
Materials component	149.5	174.6	201.9	204.2	207.8	206.3
Labor component	144.0	183.3	208.6	220.4	231.6	†245.1
Nelson construction index	146.2	179.8	205.9	213.9	222.1	229.6

*Used in computing the Nelson Index until April 1952. †Converting labor component to 60% skilled labor rather than 50:50. Transition will be complete by May 1961.

Refinery Operating Cost Indexes (1956 Basis)

	1946	1952	1954	1958	1959	Oct. 1960
Fuel cost	49.6	81.0	86.5	102.1	103.5	113.2
Labor cost	73.1	88.7	90.9	105.0	102.3	100.0
Wages	52.4	81.5	88.7	105.4	111.5	112.4
Productivity	68.3	90.2	97.1	100.3	109.0	112.5
Investment, maintentance, etc.	51.2	83.6	92.0	109.5	113.7	117.7
Chemicals cost	37.0	72.1	85.7	104.4	107.8	115.2
Operating cost indexes:						
Refinery	58.5	80.5	88.7	105.8	106.8	109.6
Process units‡	62.9	82.2	88.4	105.8	106.0	108.0

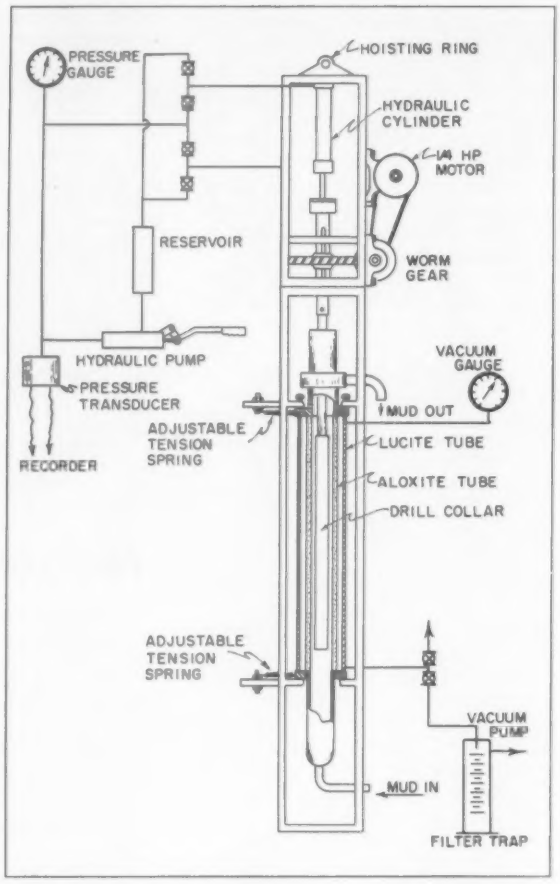
‡Add separate index for chemicals, if any are used.

Conoco's lab tests show

How to prevent differential-pressure sticking of drill pipe

You can cut down on wall sticking of drill collars and drill pipe if you use good muds. Laboratory tests which duplicate field conditions also show that you can get stuck strings loose easier by using surface-active agents in the mud. Here is an important addition to our knowledge about the things which affect pressure-differential sticking, an increasing problem with deep drilling and high-weight muds.

BY ELARD L. HADEN AND
GLENN R. WELCH
Continental Oil Co., Ponca City, Okla.



LAB SIMULATES FIELD CONDITIONS of drill collar lying in front of a porous and permeable zone. Aloxite tube is permeable and is coated with a filter cake since pressure inside is higher than outside. The same pressure differential causes collar to stick. Fig. 1.

WE'VE KNOWN for several years some of the things which cause wall sticking of drill pipe. Now, for the first time, we can see how muds of different types and compositions affect this costly problem.

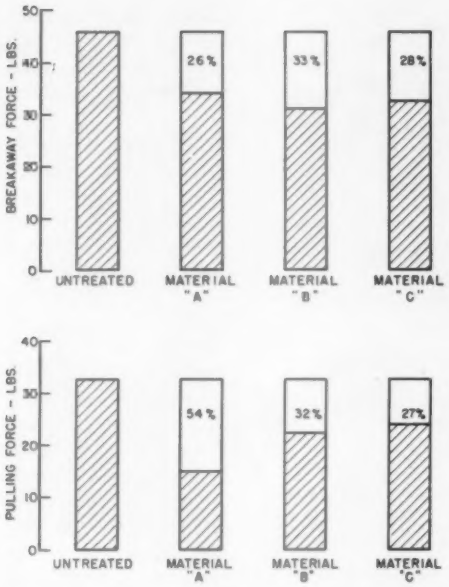
Laboratory tests made by Continental Oil Co. show mud properties play a major role in wall sticking. Briefly, this is what we conclude from the investigation:

1. The severity and frequency of pressure-differential stuck pipe can be reduced.
2. Several surface-active agents compatible with most mud systems are effective in reducing sticking.
3. Mud type as well as solids concentration determines the severity of sticking.
4. Decreasing the drill collar-filter cake contact area reduces sticking.
5. Combining these points is better protection from sticking than a single technique.
6. These techniques are not a cure-all. Constant pipe movement and good muds are essential in areas where differential-pressure sticking occurs.

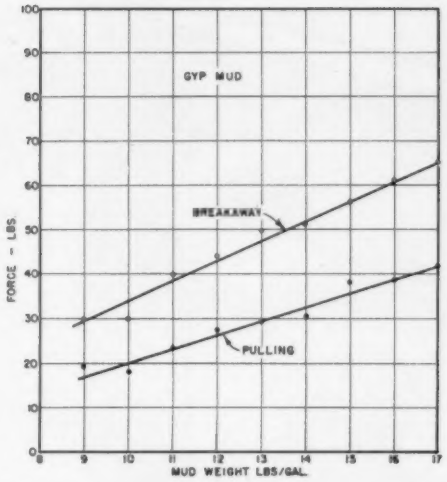
This article adapted from a paper titled, "Techniques for Preventing Differential-Pressure Sticking of Drill Pipe," presented at 1961 meeting, Southern District, API Division of Production, Shreveport.

Stuck drill pipe is not a new problem—it has plagued drillers since the advent of rotary drilling. In the last 2 years, however, pipe has stuck harder and more frequently in the Gulf Coast area and this fact prompted Continental to take a closer look at the problem. Drilling records showed that fewer than half the cases of stuck pipe could be attributed to the usual causes—debris in the hole (e.g., junk, cavings, etc.) or key seats. Moreover, there was a similarity in the unexplained cases. Sticking occurred with the bit off bottom and pipe motionless in the hole. Circulating pressures and rates were normal. The drill collars were opposite a permeable formation. These symptoms fit a type of sticking first reported by Helmick and Longley[1]—pressure-differential sticking.

Pressure-differential sticking can occur in almost any mud-drilled hole, but it is most common in abnormal-pressure areas where the differences in mud column and formation pressures can be high. Normally, this difference in pressure is carried by the filter cake. However, an object such as a drill collar can contact and isolate a portion of the cake; then, the pressure initially carried by the isolated area is transferred to an equivalent area of the drill collar. If the formation behind the filter cake is permeable and the pressure difference high, the pressure transfer is rapid. In time, the force is sufficient to hold the collar against the side of the hole and prevents its being pulled free. Dur-



SURFACTANTS REDUCE STICKING tendency of the collar; the "pulling" force is that required to keep a drill collar moving in front of a zone which will differentially stick the string. Also, surfactants reduce the "breakaway" force, that needed to free a collar already stuck. Fig. 2.



HEAVIER MUDS STICK PIPE more readily than do lighter muds. There is a uniform increase in "breakaway" force (that to free pipe) and in "pulling" force (that to keep collar moving) as mud weight increases. Fig. 3.

ing this "sticking" process, the isolated portion of the filter cake dries and shrinks as it loses fluid by filtration, thus increasing the cake-collar friction and contact area. Consequently, the longer the drill string is motionless, the more force is needed to pull it free.

Outmans[2] explained differential-pressure sticking by soil mechanics and offered a theory on why "spotting" oil releases stuck pipe. Tschirley and Tanner[3] reported success in reducing stuck pipe by using a wetting agent to promote oil coating of mud solids and drilling tools. Continental made its study in order to check some of these ideas and to find ways to prevent or free stuck pipe.

Low-pressure work. Test apparatus was set up to simulate a well through a porous formation. From this, we got the following data:

1. Pressure drop across the filter cake.
2. Force required to pull stuck collar free.
3. Volume of filtrate through the porous formation.

Fig. 1 shows the apparatus. A porous Aloxite tube (4½-in. o.d. by 3-in. i.d. by 36 in.) was concentrically centered and sealed by end plates and gaskets inside a 3-ft. length of 6-in. Lucite tubing. Foot lengths of 3-in. i.d. steel pipe were secured to the end plates so there is a continuous 3-in. i.d. hole through the assembly.

The wellbore assembly was mounted vertically in a frame and connected so mud could be circulated up through the porous tube and returned to the mud pit through a collector ring at the top of the 3-in. pipe. A modified boiler feed pump and a pair of 25-gal. drums completed the circulating system.

At the top of the frame was a removable power head containing the rotary drive and hydraulic hoisting system. The drill collar, a 30-in. length of 2-in. pipe turned true and polished, was fastened to the shaft extending below the power head. The well-bore assembly could be moved to center the drill collar or to make it contact the side of the well bore.

A vacuum pump was connected through a filter flask to the annular space between the Lucite and Aloxite tubes. When mud was circulated through the well bore, a filter cake deposited inside the tube and set up a differential pressure across the mud cake.

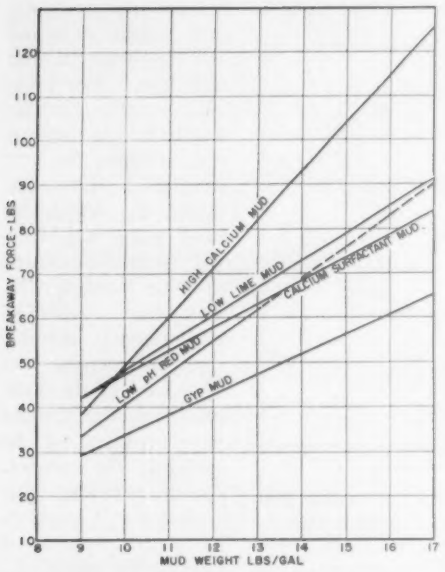
Mud was circulated through the test assembly with the drill collar centered and rotating in the well bore. The pressure in the Aloxite-Lucite tubing annulus was reduced so that pressure difference across the depositing filter cake was 10.5 psi. After 30 minutes of cake building, the well bore assembly was moved laterally until the rotating collar contacted the filter cake and the springs were adjusted to maintain the contact. Collar rotation continued for 5 minutes to assure intimate cake-collar contact.

After this "seating" period, the rotary was stopped and the collar allowed to stick. The length of the "sticking" period was determined by the fluid loss of the mud. It corresponded to the time required to collect 10 cc. under API conditions. At the end of the sticking period, the hydraulic system was used to free the stuck drill collar.

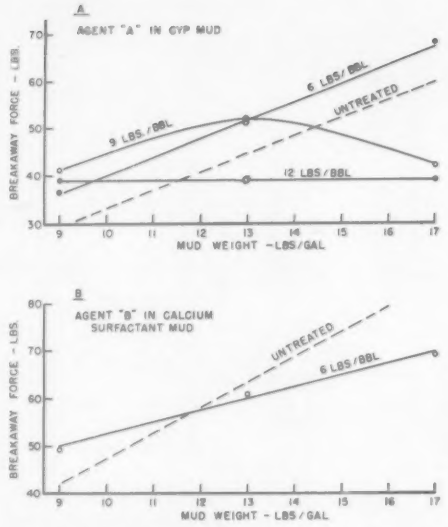
Two forces were recorded—the force required to start the drill collar moving (breakaway) and the force required to continue its movement (pulling). We repeated the "seating," "sticking," and "freeing" procedures with no differential pressure across the filter cake; this gave "base" values. The difference between the "breakaway" forces with and without a differential pressure was taken as the breakaway force required to overcome differential pressure sticking. This value was used in all data plots. "Pulling" force was obtained the same way.

Test Results

There is a similarity between differential-pressure sticking and friction. We might compare the differential pressure holding the pipe against the side of the hole to gravity acting on an object resting on a horizontal plane. Our laboratory tests showed another similarity—static and kinetic friction. We found that the pulling force (that required to keep the collar moving) was 40% less than the force to start it moving ("breakaway" force).



SOME MUDS ARE WORSE than others in causing differential-pressure sticking of the drill string. In these tests, the force necessary to free a collar is considerably less in a gyp mud than in the other types tested. Fig. 4.



ONLY IN HEAVIER MUDS do the surface-active agents reduce the force required to pull the stuck collar free. At lighter weights in tests of two different surfactants, more force was required to free the string than if no surfactant were used. Fig. 5.

If differential-pressure sticking is similar to friction, the same methods which reduce friction should also decrease sticking. We investigated three of these methods: (1) lubrication; (2) choice of materials; and (3) load reduction.

Lubrication. To test the lubrication approach, we used a pilot test with a grease-coated drill collar. Although the grease did not prevent the collar from sticking, it did greatly decrease the force required to free the collar after it stuck. Obviously, any coating put on the drill collar before running it in the hole would be worn off quickly in drilling. So, we studied materials that could be added to the mud system and constantly renew a film on the drill string.

Our tests narrowed down to three surface-active agents and we measured their breakaway and pulling forces in an aged 15-lb. per gal. gyp-base mud. Results of these tests are shown in Fig. 2. Breakaway force was roughly the same with all three materials; however, one lowered pulling force more than the other two.

Although this approach is no cure-all, the use of surfactants should reduce sticking by lowering the force required to pull free.

Effect of materials. Reducing friction (sticking) by changing materials did not look promising. We found that a number of materials have lower coefficients of friction with clays than does steel, but they are impractical for drill collars. This left the filter cake as the only material that could be changed or modified. So, we made tests with several different types of unweighted muds. Differences in breakaway and pulling forces for the various muds were minor.

We then studied the effect of solids concentration on sticking. We measured breakaway and pulling forces for a gyp mud as weight was raised from 9 to 17 lb. per gal. by adding barites. The forces at 17 lb. per gal. were twice those at 9 lb. per gal. Fig. 3 plots breakaway and pulling forces vs. mud weight.

The filter cakes underwent two changes as barite concentration increased. The cake became more abrasive when rubbed between the fingers, and the water content decreased. Both of these factors would raise the coefficient of friction between collar and cake.

As a check, we repeated the study with a low-lime mud. Again breakaway and pulling forces increased linearly with mud weight, but at a faster rate than gyp mud. The difference in breakaway forces for the two muds at high mud weight was appreciable.

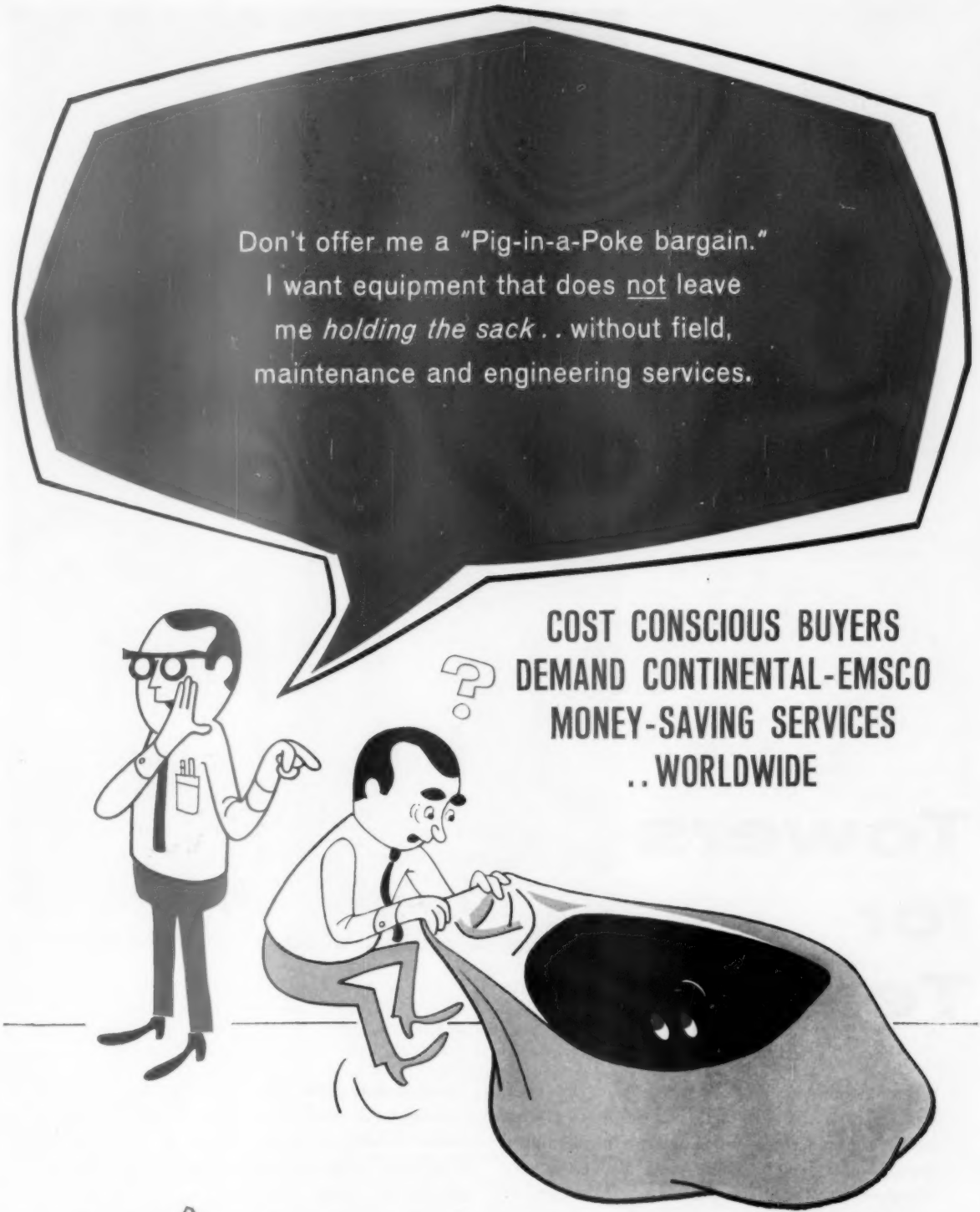
As a result of this finding, we checked several common mud systems. The results are given in Fig. 4 which plots breakaway and pulling forces vs. mud weight for gyp, low-pH red, calcium - surfactant, low-lime, and high-calcium muds. These data indicate that mud type does affect sticking, particularly at high mud weights, and that gyp mud has appreciably lower sticking tendency than the other muds tested.

Let us apply these results to a field example to point out how much difference there is among various muds. If an 80,000-lb. pull freed a drill string stuck in a 14-lb. per gal. gyp mud, 106,000 lb. would be required for a low-lime mud, and 114,000 lb. for a high-calcium mud.

We found that lubricants reduce the effect of higher solids concentration. In tests with gyp mud, when sufficient lubricating agent was added, the sticking tendency of the mud could be made independent of the mud weight. Fig. 5A plots the results.

Results were similar with a calcium-surfactant mud system as Fig. 5B shows. Less of the agent was needed to reduce sticking in this system.

Reducing the load. Our third technique for reducing sticking was to reduce the load, or force holding a collar against the side of the well bore. This force is directly proportional to the area of the collar in contact with the filter cake. If the contact area is less, the force holding the collar is less. We believe that collars fitted with standoff bands, shown in Fig. 6, should be easier to pull free than conventional collars. Our tests with a scale-model collar in a weighted low-lime mud showed this to be true. Breakaway force for the modified collar was


Don't offer me a "Pig-in-a-Poke bargain."
I want equipment that does not leave
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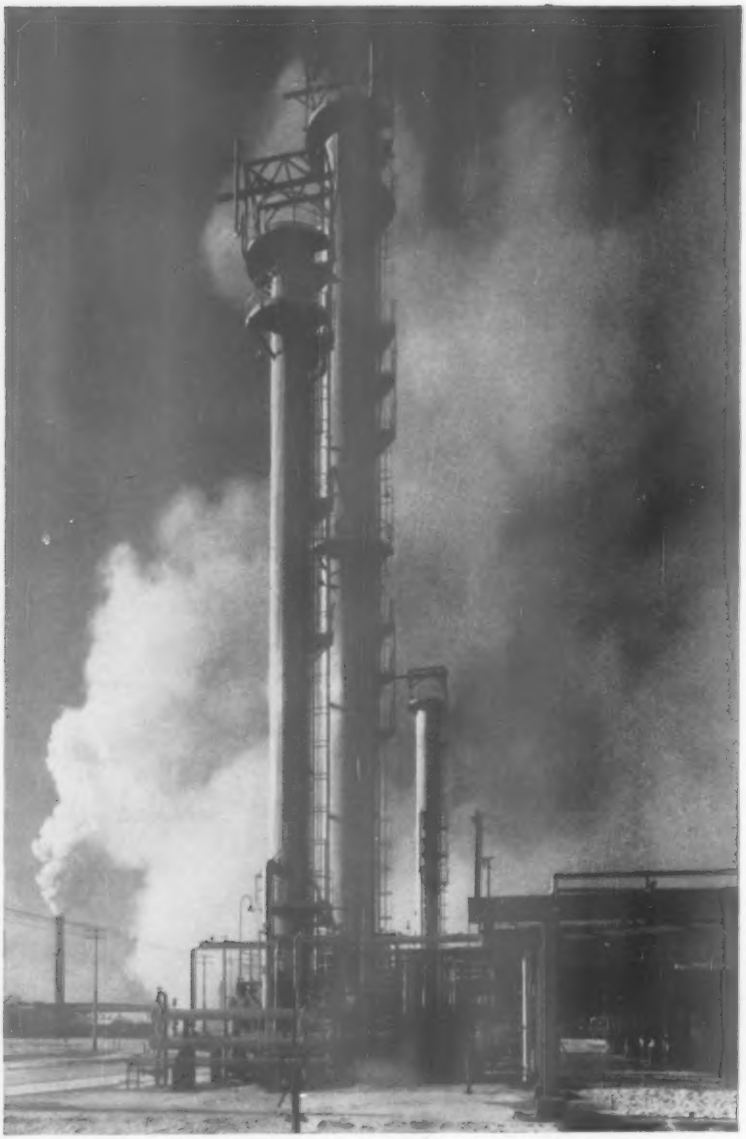


Towers for Texaco

When it comes to producing vessels of this kind, experience on the part of the fabricator is a great asset to the main contractor. To have a fully equipped plant is not enough. There must also be a very advanced knowledge of the actual techniques of steel fabrication. New materials and procedures are always being developed and to reap the benefits, they have to be properly applied.

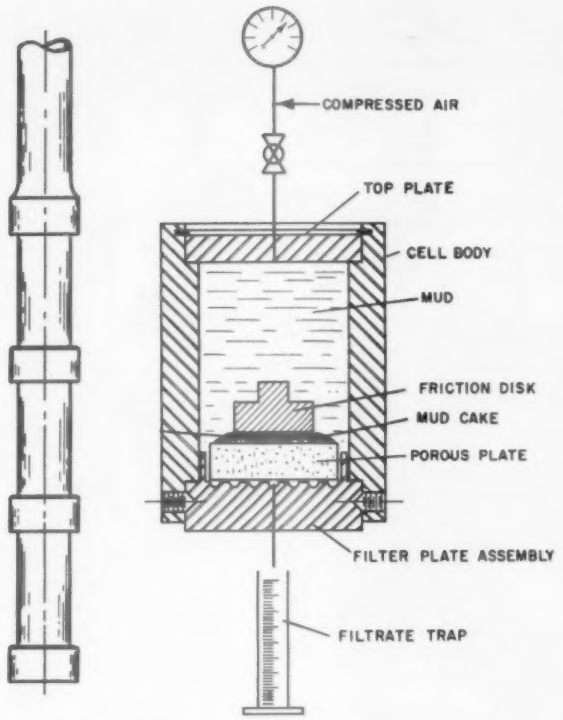
These towers were fabricated by the Platework Division of Dominion Bridge to designs supplied by Foster Wheeler and are typical of hundreds that Dominion Bridge has made for the oil and chemical process industries.

Dominion Bridge plants across the country are well experienced in this business and the sum total of this experience is applied to every new contract.

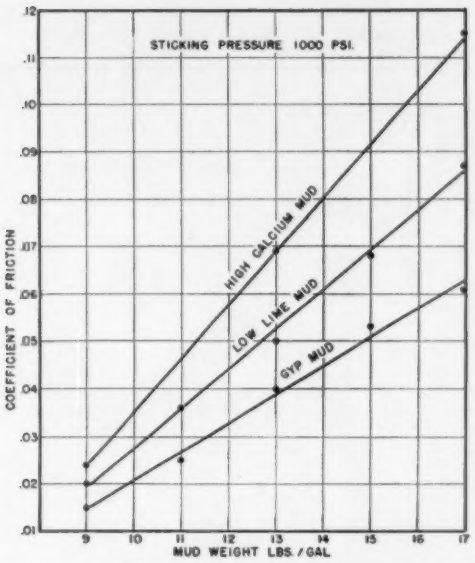
72

Platework by **DOMINION BRIDGE**

DOMINION BRIDGE COMPANY LIMITED - FIFTEEN PLANTS COAST-TO-COAST IN CANADA



LESS WALL CONTACT is the goal of this modified drill-collar design (left). Theoretically, the less contact, the less the sticking force. In tests, however, there was a buildup of solids at the edges of the raised bands. This buildup increased the sticking force. Fig. 6. **HIGH-PRESSURE CELL** (right) is much simpler than the low-pressure apparatus shown in Fig. 1. While this cell does not duplicate the geometry of the well bore, it does allow tests to be run quickly with results which can be duplicated. Fig. 7.



RESULTS ARE VERIFIED; these tests were run to measure the coefficient of friction at various mud weights in the high pressure cell. They prove that the high and low-pressure cells give essentially the same results since plot resembles those for "breakaway" and "pulling" forces. Fig. 8.

60% less than for the conventional collar. Pulling force was 75% less. Although these results are impressive, they were less than we anticipated. After each test, there was mud cake build up above and below each band, thus increasing contact area. In field use a collar of this type would not be as effective as our tests show because irregularities in the well bore would further alter the collar-filter cake contact pattern.

High-Differential Work

To check the results in the low-pressure studies, we made a high-pressure test unit. The apparatus is designed to operate at pressure differential up to 1,500 psi. and is distinctly different from the previous system. Flat disks and filter cakes replaced curved pipe and borehole surfaces, thereby eliminating variations in contact area, as shown in Fig. 7. The cell resembles a high-pressure filter press with both ends removable. A permeable disk serves as the filter medium. The desk was cemented in a recess machined in the bottom plate. Grooves below the disk provide an outlet for the filtrate. Set screws secure this assembly in the cell body.

In a sticking operation the cell was filled with mud, the top plate installed and locked in place with a snap ring. A filter cake was deposited at the differential pressure under study by connecting the cell to a regulated high-pressure air supply. After 30 minutes, pressure was released and the top plate removed. A disk with a polished lower face and a square stud on top was placed gently on the surface of the filter cake. Pressure was reapplied after replacing the top plate. At the end of the sticking period pressure was released, top plate removed, and excess mud poured from the cell. Set screws were loosened and filter-plate assembly with stuck friction disk attached was withdrawn from the cell body.

We used a special torque indicator to measure the torque required to spin the stuck disk free from the filter cake. Knowing the torque, disk size, and applied pressure, we calculated the coefficient of the friction between disk and mud cake.

Because the system has not been in operation very long, we have not checked all of our low-pressure findings. We did make a spot check on three muds which more or less duplicated one part of our low-pressure data. These results are shown in Fig. 8 which plots coefficients of friction for gyp, low-lime, and high-calcium muds vs. mud weight at 1,000-psi. pressure differential. The rapid increase of the coefficients with mud weight reemphasizes the effect of mud type and mud-cake composition on sticking.

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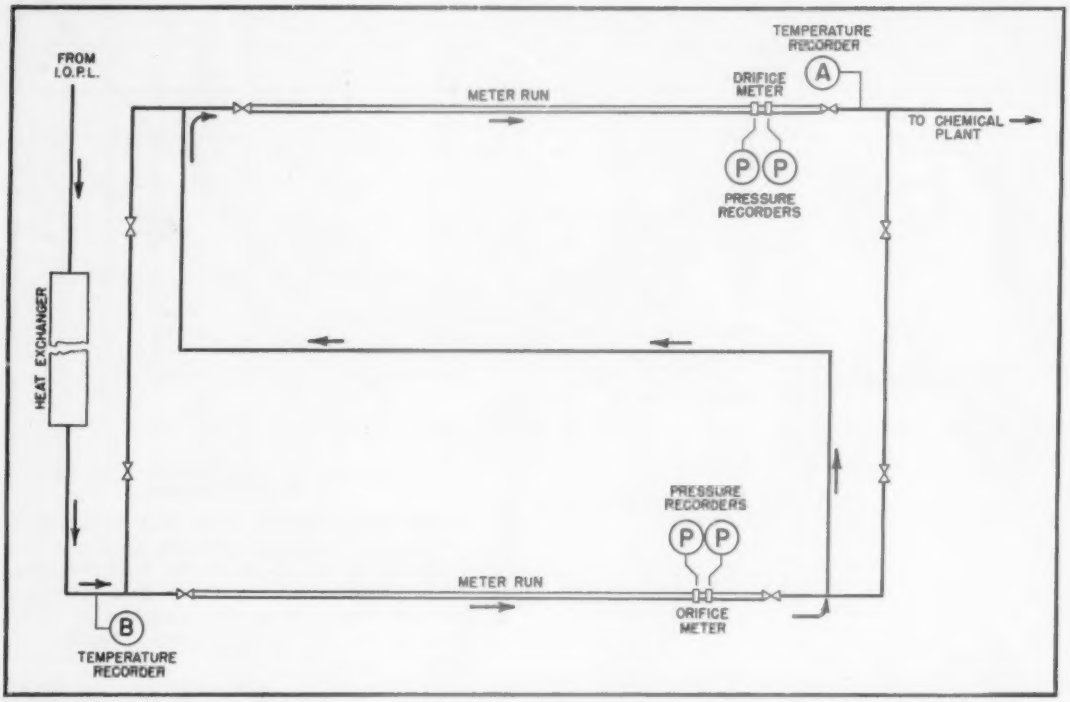
2. Outmans, H. D., "Mechanics of Differential Pressure Sticking of Drill Collars": Trans AIME, Vol. 213, 265 (1958).

3. Tschirley, N. K., and Tanner, K. D., "Wetting Agent Reduces Pipe Sticking," The Oil and Gas Journal, Vol. 56, No. 46, 165, Nov. 17 (1958).



SCHEMATIC DIAGRAM of Interstate's LPG metering facilities shows temperature recorder (A) installed on downstream end of orifice meter, which permits more accurate computing of volumes when averaged with upstream temperature recorder (B).

Boost accuracy by averaging temperatures

On LPG orifice-meter run, recorders both up and downstream compensate for changes, yield better results.

LESLIE MANGUM, Interstate LPG meterman, changes temperature recorder chart at delivery facilities adjacent to a petrochemical plant in the Baton Rouge area. Averaging downstream temperatures with figures on the upstream recorder originally installed produces more accurate readings for figuring volumes delivered.

AVERAGING temperature readings both upstream and downstream of an orifice-meter run on an LPG system yields more accurate results than readings taken at the upstream end only.

Interstate Oil Pipe Line Co. learned this the hard way and now makes it standard practice. It has enabled the company to eliminate apparent shortages, increase operating efficiency and effect substantial annual savings.

Interstate's operations include an LPG system in the Baton Rouge-Sorrento area in South Louisiana. One of its services is the transportation of ethylene between the Baton Rouge refinery of Humble Oil & Refining Co. and storage caverns in the Sorrento salt dome. The flow can be in either direction, depending on seasonal demand. From this system Interstate handles the deliveries of ethylene to several plants in the area.

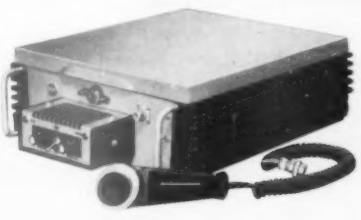
Wisely used transistors enhance the value of RCA "LD" 2-Way Radio and give it built-in dependability

In designing this efficient new "LD" equipment, RCA engineers wisely gave special consideration to the transistor. Only "stock" transistors capable of being serviced with existing test equipment and techniques are used—and only in circuits where they do the best job in cutting battery drain. Tubes are used where they can stand up under high temperatures, heavy voltages—jobs that tubes do best.

As a result the "LD" is not OVERtransistorized, is compact, yet accessible, miserly in power consumption yet value-packed to pack a punch in performance.

Leave the radio on when engine is off—battery drain is negligible. Use it on the roughest roads—transistors and sealed circuits give added assurance it can take it under gruelling conditions.

Specify the RCA "LD" and you can be sure it will stand in back of your endorsement. Lease or purchase plans available. RCA authorized service available. Ask your RCA Representative for complete descriptive literature. Or mail coupon below.



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☐ Please send me FREE literature on the new RCA Transistorized "LD" Mobile Radio.

☐ Have RCA Communications Specialist contact me and explain why this is today's best value in 2-way radio.

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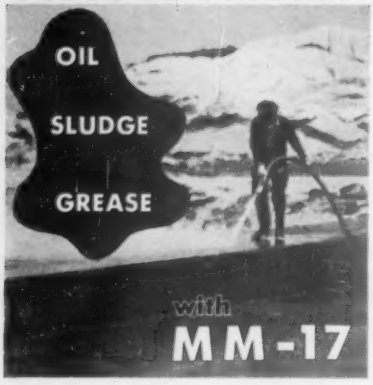


Sea wall at Scituate, Mass., where heavy deposit of bunker oil from sunken tanker was completely removed by spraying MM-17 on oil and hosing off with water.

- **Quickly and safely emulsifies oil spills**
- **Flushes clean with fresh or salt water**
- **Non-explosive, no toxic vapors, does not burn skin**

MM-17 overcomes emergencies caused by oil spills on land or water. It is the safest and most efficient emulsifier extensively used for this purpose.

MM-17 cuts through deep layers of heavy oil and sludge where ordinary solvents fail. Here is a scientific cleaner for oil tanks, pipe lines, piers, loading platforms and oil handling equipment.

MM-17 is sprayed or brushed on the surface to be cleaned. In minutes, oil and grease can be hosed off or wiped away.

Get ready now for annual clean-up and emergencies. Order MM-17 today and have it on hand when you need it.

Single drums (55 gal.) . . . . . $2.42/gal.
Six drums on same order . . . . $2.18/gal.
Bulk shipment prices on request.

FREE Barrel Drain Truck with first order. Listing for $31.50, this truck is yours free with your first drum of MM-17.

ROCKLAND INDUSTRIES, INC.
CHEMICAL DIVISION
65 Grove Street
Rockland, Massachusetts
Triangle 8-5340

On the Job

PIPELINING

Readings differ. When apparent shortages were detected in metering of products, the cause was found to be the difference between meter readings of products delivered to two plants and the actual volumes.

Even though the metering had been done in accord with established industry practice, some modification was obviously in order. Since the product cools appreciably during its passage through the metering facilities, it was decided to install a second temperature recorder at the downstream end of the meter run.

By averaging the readings from the two recorders, greater accuracy in computing volumes results. The greater accuracy has been proved by extended tests made since the original installation.

Carlos C. Rabb, Jr., now district foreman for the Ferriday district, and Donald E. Cox, engineer, currently on a construction loan assignment, share credit for the idea. They divided $4,000, the highest amount ever paid by Interstate for an employe suggestion under the company's Coin-Your-Ideas program.

THIS GINNY, built by Panhandle Eastern's Liberal, Kan., warehouse staff, reduces both time and cost and improves safety of unloading pipe. It was designed to handle pipe used in gathering lines but has been useful in many other services.

Unit unloads pipe safely, speedily

Cost cut two-thirds by ginny assembled from used material by warehouse staff of Panhandle Eastern Pipe Line Co. at Liberal, Kans.

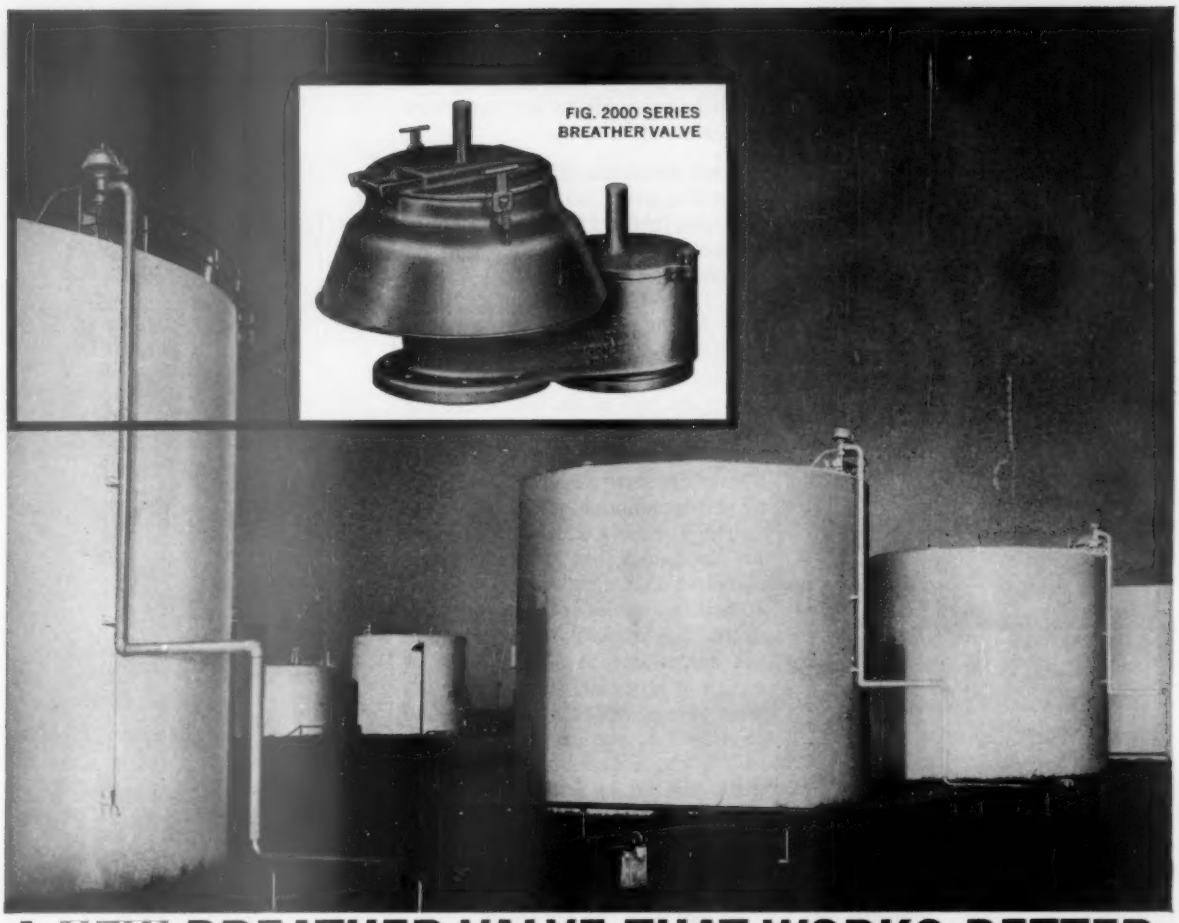
LINE PIPE can be unloaded and handled speedily, safely and economically by a ginny put together by the Liberal, Kans., warehouse staff of Panhandle Eastern Pipe Line Co.

The ginny was built almost entirely from used material at a total cost of about $1,000.

It's fast. It unloaded three cars of pipe at one location and was moved 50 miles to another where it unloaded two cars all in a single day.

It's economical. Estimated cost of unloading a carload of pipe is one third of the cost of the old method. The ginny can also be used to move other things such as steel goods and meter houses.

It's safe. The operator is protected by a steel guard and is seated



A NEW BREATHER VALVE THAT WORKS BETTER, COSTS LESS, OFFERS MORE...

with easily accessible and interchangeable pallets

3-in-one valve flexibility... low-cost conversion

Varec's Fig. 2000 Series Breather Valve provides new built-in flexibility and efficiency... yet costs less to buy and maintain. It offers choice of any one of three pallet designs—air cushion, diaphragm, or metal-to-metal. It converts, to meet your changing needs, into any of these designs without adapter kit... just by replacing pallets. The pressure and vacuum pallets of each valve are interchangeable, cutting maintenance problems.

Quick opening covers... fast, easy inspection

Two separate opening covers permit fast, independent access to either the pressure or vacuum pallet. Total cover opening averages 5 seconds per valve. The covers have no loose parts that can be lost. Replacements for air cushion or diaphragm pallets can be made in two to three minutes.

Better design for improved performance

This new Varec valve is better-built—with many quality anodized parts and protective port screens. It weighs 50% less than older models. Drip rings on pallets keep moisture away from seating surfaces, and the hyperbolic design greatly reduces "blow down," which results in vapor savings. Both air cushion and diaphragm pallets have inner layers built in for added protection.

For complete information on the Varec Fig. 2000 Series Breather Valve, write for Varec Bulletin No. CP-2701, Dept. OGJ-1400-1.

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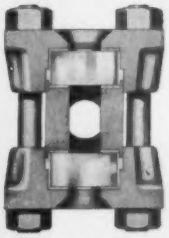

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STRAHMAN VALVES, Inc.
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On the Job

PIPELINING

so that he is able to see the entire operation at all times.

Used material. This is the material that went into the ginny: Two pipe pole trailers of no further use as such, a four-cylinder Waukesha engine, one Tulsa No. 10 winch, one Tulsa No. 23 winch, a floor plate for the bed, and 2-in. and 3-in. pipe for the boom.

An 8-in. H-beam was placed across the end of the bed where the boom was mounted. The beam extended to each side of the boom where legs were added to the boom to provide solid footing.

The Tulsa No. 23 winch was used for the cables that lower and raise the pipe. The winch drum was split so that two cables could be mounted on it. This made it possible to pull the cables out to any position or length of pipe. The small winch was used to raise or lower the boom and thus provide vertical lift.

The raised seat for the operator gives him an unobstructed view of the operation at all times. It permits him to see into the inside of an ordinary railroad gondola car. He is protected by a guard which does not obstruct his vision.

Easily transported. The ginny is not self-propelled but it can be loaded on a float and moved easily. It has a set of guide wheels which make it readily maneuverable by truck or by other means of towing in the yard.

It has been used both at rail yards and in other pipe-handling yards within a 100-mile radius of the Liberal plant.

The idea for the ginny was conceived by W. E. "Bill" Scott, Panhandle Eastern's manager of stores. It was put together by K. W. Markley and O. T. Morgan under the supervision of E. L. "Duffy" Duff, warehouse superintendent at Liberal.

Before the introduction of the ginny, pipe was unloaded with a 2-ton truck with a winch and an "A" frame. The operator sat in the cab of the truck. With the controls in front of him and the operation behind him, it was a slower, more dangerous, and more costly operation.

HARRISBURG FLANGES

Among OIL PRODUCERS, SHIP BUILDERS, PIPE FABRICATORS AND THE CHEMICAL INDUSTRY, Harrisburg Steel has maintained a long-standing reputation of high quality and integrity.

Flanges produced by Harrisburg are made to A.S.A. standards. They are available in threaded, butt-welding, slip-on welding, Van Stone and blind types. They are shot-blasted and dip-coat finished with a rust preventative black lacquer. Prompt shipment in small quantities or carload lots.

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Improve your Engineering I.Q.*

* INCOME QUOTIENT

Engineering-Management Status: Dream or Mirage?
Technology an asset, but other training required

The complexity of modern industry has created a great demand for management personnel with engineering training. Surprisingly, there is a very short supply of such men, i.e., engineers with enough potential to be groomed for executive functions.

Historically, as big industry moved out of restricted, private ownership into broader public ownership, two things happened, both of which added to the demand for "management men." First, public ownership made possible more diversified management, as opposed to the centralized control characteristic of family ownership. Second, the complications and diversification of modern industry have sharply increased the ratio of executives to employees. Where the ratio was formerly approximately one executive to 100 employees, it is now more like one to 35.

Recognizing that employment has increased by about one-third during the same period, the need for management personnel becomes clearer. Not only do few engineers graduate from school ready to be managers, few of us study courses as undergraduates which would prepare us for executive leadership later in our careers. Finally, as a prerequisite for managing the affairs of others, there is no substitute for experience.

WHAT DO YOU REALLY WANT?

If you are facing this important decision in your present status, get your future into focus before taking the step. Decide what you really want from your personal and business careers. It is sometimes too easily assumed that all men want to move on to higher, executive positions. With few exceptions, all men pay lip service to "wanting to get ahead," but too many of us hoodwink ourselves into believing this means management responsibilities, without fully recognizing the significance of such a step.

As a matter of fact, all men *don't* want to advance into management. Some, however, find this out too late, for unless they are psychologically and emotionally suited for the rigors of management, the driving ambition to assume more leadership, responsibility and authority may not in itself be a worthwhile goal. If a man is doing well where he is, it may be a mistake for him to try to move into the management orbit, for the move to management is not the only door to advancement.

WRITE FOR YOUR COPY TODAY

. . . the growth of an engineer, either into greater achievement in technology or into executive responsibility, is a matter of gratification and importance to Western. In our own organization, as well as in our customers' firms, we have seen "fledglings" make lasting contributions to the science of processing and the business of management. Recognizing the importance of an early and correct choice of each man's road to success, we have devoted one of Western's "professional development" booklets to this important subject, and there is a copy waiting for you, without obligation . . . Also without obligation, we offer our assistance in the solving of your next heat transfer problem.

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March of progress in petroleum processing...

The 30's—THERMAL CRACKING!

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NOW...ISOCRACKING!

*Isocracking** is now applicable to straight run gas oils, catalytic cycle oils, thermal gas oils and coker distillates of higher end point than previously announced.

Refiners can produce high-quality gasolines and jet fuels from refractory distillates . . . at lower investment and operating costs than were ever thought possible by hydrocracking.

The benefits of *Isocracking* have been proved commercially in the Richmond, California plant, now in its second year of full-scale operation.

Another large plant is under construction and a third is on the drawing boards. Here is evidence of an attractive return on investment.

For complete details, write:
California Research Corporation
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CALIFORNIA RESEARCH CORPORATION
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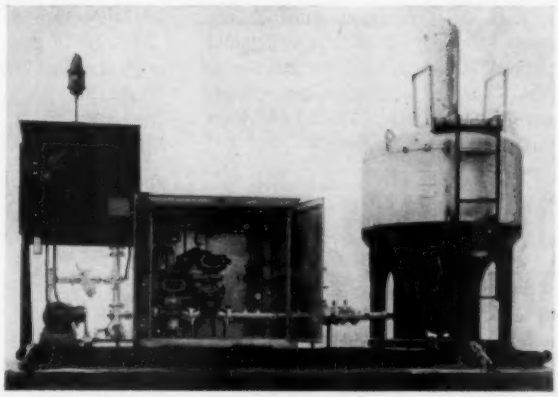
▶ ▶ ▶ New Equipment Section

This week's SHOWCASE features . . .

Four connections hookup LACT



. . . unit now on the market. Using a positive-displacement type of meter, the unit is designed to meet the needs of both producer and pipeline. The four connections required for operation are: (1) inlet line, (2) pipeline delivery line, (3) rejected oil line, and (4) electric power.

When the unit operates, a pump moves oil from storage past a b.s. and w. monitor probe. If the fluid does not meet pipeline specifications, it is sent to the treater or to wet-oil storage. The positive-displacement meter, equipped with automatic temperature compensation, measures pipeline-quality oil. Proportionate samples of the oil are taken during delivery to the pipeline. A back-pressure and shutoff valve is used to achieve accurate meter operation and positive control.

Optional equipment includes air eliminator, meter house, and an API meter prover. Source: **National Tank Co., Drawer 1710, Tulsa, Okla., U.S.A.**

Portable water-flood unit

. . . now offered is designed to serve as an automatic injection and filter system. A natural-gas engine serves as the prime mover to drive the injection pump, filter or feed pump, and backwash pump. A drive and clutch arrangement provides for operation of any combination of pumps according to requirements.

Included on the skid mounting are the engine, injection, feed, and backwash pumps, filter, and piping and control systems. The engine is equipped with an automatic level control and an exhaust condenser for automatic cooling-system level. The pumps are made of corrosion-resistant materials, and the filters are plastic-lined.

Continuous injection is afforded as the feed pump maintains the filtered water supply at proper levels, the maker says. The filter is automatically backwashed when necessary. An unusual loss of fresh water will disengage the injection pump while the feed pump restores the level. Source: **Waukesha Sales & Service, Inc., 12320 Main, Houston 35, Tex., U.S.A.**

●

Hydraulic oil

. . . now on the market, a custom-engineered type tradenamed LE Brand, is claimed to possess three important characteristics which contribute to over-all better system operation: (1) maintenance of proper operating viscosity over a

Want more facts about equipment or copies of product literature described in this issue?

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SHOWCASE . . .

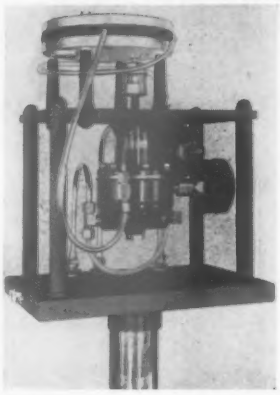
New Equipment

wide temperature range, (2) extra-high film strength to resist extreme pressures prevalent in hydraulic systems, and (3) a naturally high resistance to heat, oxidation, and foaming and including the addition of antioxidation and antifoaming agents to give protection against internal damage to hydraulic systems. Source: **Lubrication Engineers, Inc., P. O. Box 7128, Fort Worth 11, Tex., U.S.A.**

Continuous gas sampler

. . . now on the market is claimed to give accurate determination of chemical and physical properties of a gas. The Model G sampler during 7 days will accumulate at a constant rate a sample of gas to a final pressure at or near 300 psig. from a sample source. Minimum pressure required of the source is 340 psig.

Using a gas drive, the sampler is available for sample ranges from 30 to 300 psig. The gas sample is gathered in a portable container for easy access to the laboratory.



According to the maker, the sampler can be used in any hazardous area where vaporproof equipment is required because it needs no external power source. Source: **Arcco Instrument Co., Inc., 7144 E. Condor, Los Angeles 22, Calif., U.S.A.**

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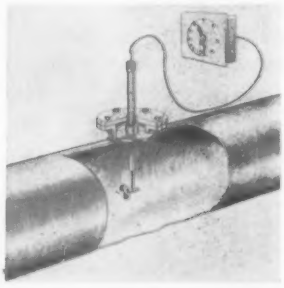


Flow transducer for 30-in.

. . . pipelines and larger. The improved Mark V transducer, in the form of a probe, is claimed to be rugged and reliable and to cause only a low pressure loss. Without special tools or equipment, one man can install it through a flanged fitting fabricated in the pipeline.

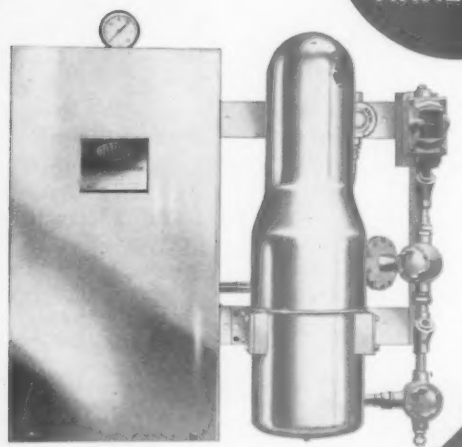
The maker says the device can meter any fluid that can be safely contained in stainless steel. This includes oils, fuels, abrasive fluids, and most slurries, acids, and caustics. Pressures can range to 5,000 psi. and temperatures to 600° F.

The transducer can be remotely located and the signal telemetered many miles. Systems can be provided to permit indicating, recording, controlling, and totalizing of flows. The unit senses the rate of fluid flow as a product of the dynamic forces acting upon a fixed body immersed in the flow stream. Source: **Ramapo Instrument Co., Inc., 8 First Street, Bloomingdale, N. J., U.S.A.**

OPTIMUM RETURNS THROUGH QUALITY CONTROL

• **A proved cost-cutter,** now operating in over fifty refineries, gasoline, and chemical plants. • **Increases yield and improves quality** by accurately and **continuously** monitoring ASTM end-point. Delays between quality change and compensating control are eliminated. Allows closer operation to end-point specifications. • **Reproducibility** far exceeds laboratory method. • Write for Technical Bulletin 5900-11.

Maximize your profits with the TOTCO END-POINT ANALYZER



Totco also makes an Initial Boiling Point Analyzer. Write for Technical Bulletin 1259-11.

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- **LEASE CRUDE** or other available light hydrocarbons may be used.
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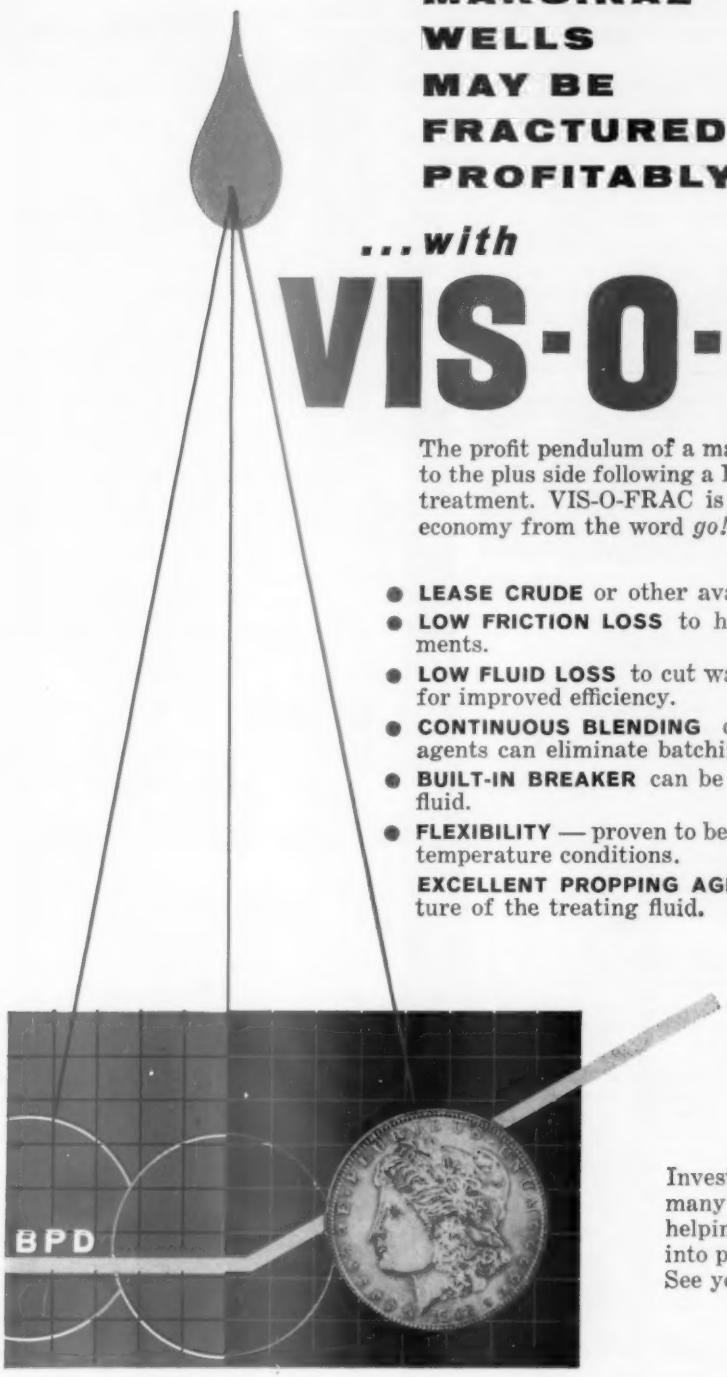
- **LOW FLUID LOSS** to cut waste — retains more fluid *in the fracture* for improved efficiency.
- **CONTINUOUS BLENDING** of crude, gelling agent and propping agents can eliminate batching.
- **BUILT-IN BREAKER** can be employed to speed return of fracturing fluid.
- **FLEXIBILITY** — proven to be effective over a wide range of depth and temperature conditions.

EXCELLENT PROPPING AGENT CARRIER due to the gelled structure of the treating fluid.



Investigate VIS-O-FRAC. It is one of many Halliburton fracturing techniques helping operators convert marginal wells into profitable producers the world over. See your Halliburton man *soon!*

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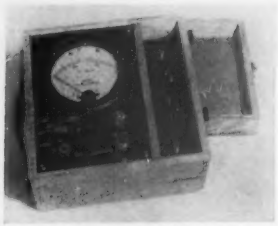

Pipe-to-soil voltmeter

. . . just put on the market is said to provide a simple and suitable meter for routine testing. According to the maker, the Decca voltmeter accurately measures pipe-to-soil potentials under any resistance condition.

The meter is a sealed shock-resistant type. An oak case with removable lid houses the meter. A 4½-in. meter serves as both a galvanometer and as a voltmeter.

Meter range is 0 to 1.5 volt. Sensitivity is reported to be 10,000 ohms per volt. Accuracy is claimed to be 2.13% or better. Source: **Agra Engineering Co., 1537 E. 10th, Tulsa, Okla., U.S.A.**

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NEVER-DRY PEN
Writes for Months
REPLACES OTHER MAKES • USES REGULAR INKS
Regardless of pulsations or other causes of ink failures this Never-Dry Pen will make clean and complete records.
CHECK THESE EIGHT FEATURES
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5. No ink slopping or dripping in meter cases or on floor.
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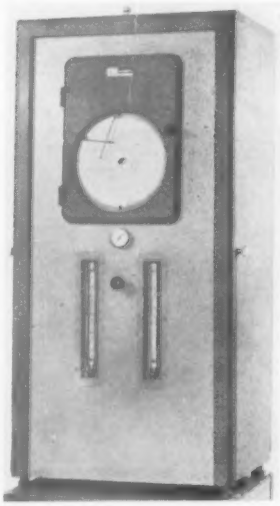
MANUFACTURERS OF PRECISION INSTRUMENTS

Filtration system

. . . for water-flood injection or disposal wells just announced uses a silica cartridge which can be backwashed many times, the maker says. The Deco adsorbent type of filtration system is claimed to offer considerable savings by eliminating down time lost in changing cartridges and by reducing cost of repairs and meter parts.

The silica cartridge ranges in size from 10 to 75μ. The unit shown uses two filters which make up an interacting backwash system. Any number of filters can be connected to one source. A 2-in. manifold is included in the system.

Both models measure 27 in. high, over-all. Connections are 1-in. N.P.T. The filter weighs about 35 lb. Source: **Frank Wheatley Corp., 125 W. 1st., Tulsa, Okla., U.S.A.**



Mechanical gravitometer

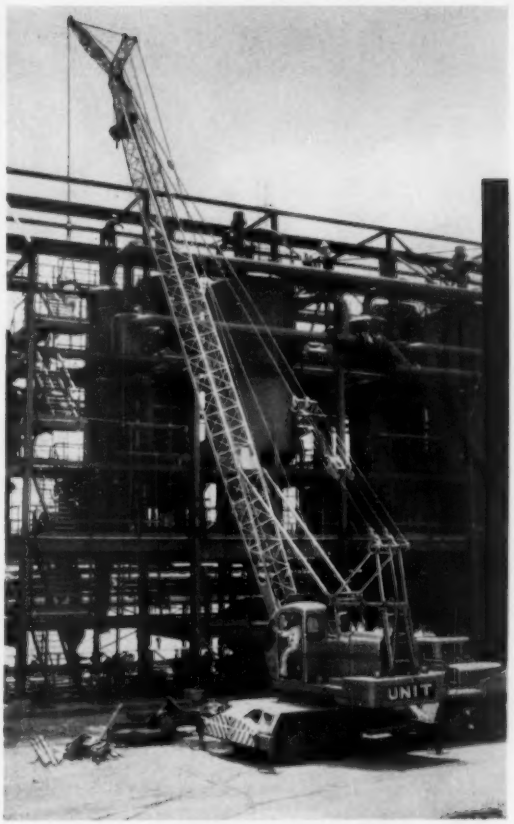
. . . has been brought out which is said to measure specific gravity for use in orifice-meter measurement under any climatic extremes. No controlled or conditioned atmosphere is required, and no complicated or critical adjustments are required for atmospheric variations, the maker says.

Let UNIT crane "Profit-Lifts" get you back on stream faster

With turnaround the largest single item of operating expense in your plant, lengthy shutdowns, while rotating equipment, are costly. That's why it is so important to get back on stream quickly — why it is so important to include a UNIT crane in your equipment handling fleet.

With their short tail swing and automotive-type power steering, UNIT cranes on rubber are able to maneuver in close quarters. "Straight-in-line" mounting of the crane's engine, worm drive and main machinery means smooth, direct power flow . . . maximum operating efficiency. Disc-type operating clutches provide uniform, positive engagement . . . loads are picked up smoothly and evenly. A fully independent boom hoist, providing power control of raising and lowering, permits extreme accuracy in load handling. And you get long-boom stability that lets you reach over existing machinery and framing to spot in new assemblies.

UNIT cranes on rubber are offered with either wagon or truck mounts. Capacities range from 10 to 40 tons. The UNIT dealer in your area will gladly give you full details.



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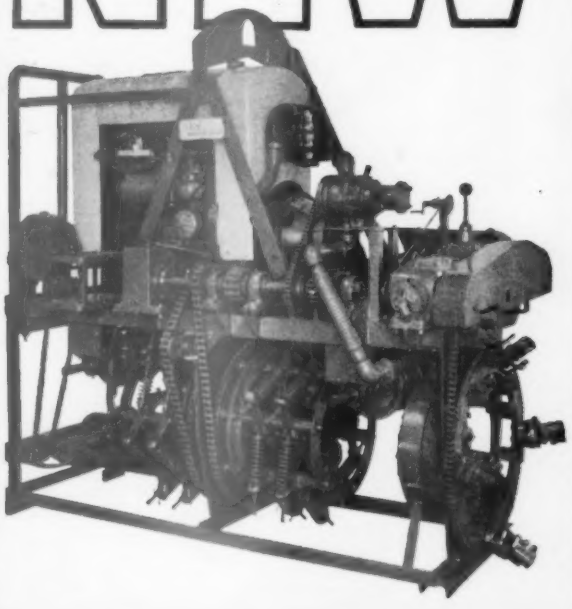
NEW



CROSE COMBINATION CLEANING & TAPE WRAPPING MACHINE

AVAILABLE IN FOUR MODELS

The New Crose Combination Cleaning and Tape Wrapping Machine has variable speed tape wrapping head; built-on blower to remove dust from pipe prior to applying tape, and baffles incorporated into machine's design to protect wrapping area from dust. Four models — comparable to the Crose Cleaning and Priming Machine — handle these pipe sizes: 2"-4"; 4"-16"; 16"-32" and 34"-40".

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Try a RIDGID Spiral Reamer, and you'll quickly feel how it reams its way into pipe, conduit, metal holes or wood without effort. Heat-treated cutting edges give maximum service life. Ratchet-action handle makes work easy in close quarters.

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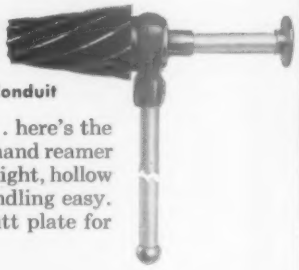
RIDGID No. 254
Spiral Reamer
for 2½" to 4" Pipe and Conduit



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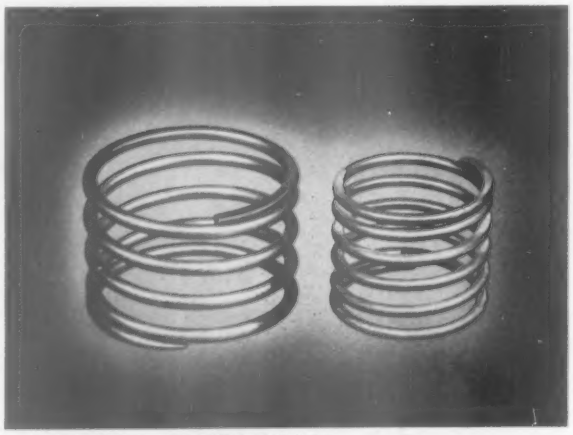

DUAL DESIGN!...

Designed by Line Scale engineers, the dual, concentric spring arrangement—optional on Line Scale valves and seats—enables more spring material to be used in a limited space; essential for efficient operation of high speed pumps. This feature, combined with other advantages, makes Line Scale the outstanding manufacturer of valves and seats.

Line Scale valves and seats are available for all reciprocating pumps, regardless of size, age or model. For prices, specifications, and further information, write to:

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The maker further says that the gravitometer can be installed without the need for highly trained technicians, and that it is easily operated and maintained. It is completely automatic. Source: **UGC Instruments, Div. of United Gas Corp., P. O. Box 1407, Shreveport, La., U.S.A.**

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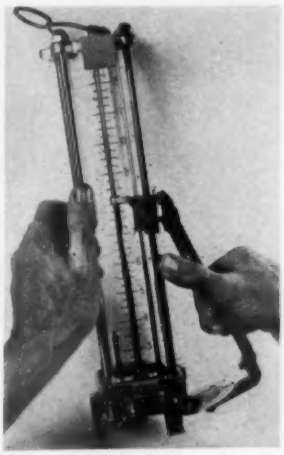

Oil sampler

. . . features a full-opening, side-mounted shutter valve which can be cocked with two fingers. A slight pull on the line or at a preset distance above a tank bottom by a calibrated rod trips the valve.

Construction material for the sampler may be cadmium-plated cast brass or aluminum. Graduated in ¼-in. divisions, the 2-in. barrel comes in three materials: tempered glass, aluminum, or plastic. Four sampler sizes are available: 12, 16, 18, and 24 in. Source: **W. H. Curtin & Co., P. O. Box 118, Houston 1, Tex., U.S.A.**

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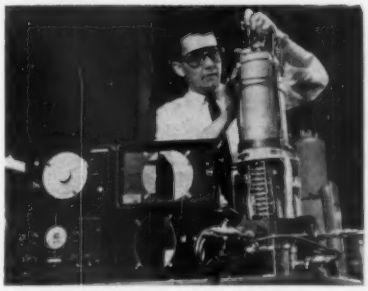
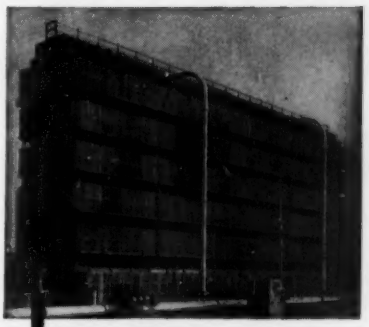


High-speed chromatographic system

. . . permits closed-loop process control, the maker announces. The Model 284-B Process Vapor Frac-

NEW LIFE FOR OLD COOLING TOWERS



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tometer is designed for use on multicomponent process streams. Typical uses include both monitoring and closed-loop control of distillation tower fractionators, alkylation reactors, hydrogen sulfide-to-sulfur dioxide ratio in sulfur-recovery plants, and oxygen and carbon monoxide in regenerators of catalytic cracking plants, the maker says.

The instrument delivers control signals of 0 to 4 ma., 0 to 50 volts, proportional to the concentrations of the measured components. When used with a milliampere-to-pressure transducer, it is suited for use in pneumatic control systems, the maker says.

The system incorporates a sensing unit and a multicomponent peak reading controller. A high-speed pneumatic valve in the sensing unit introduces gas samples into the chromatographic column in less than a second. The sample passes through one or more columns, which separate it into its components.

The components are eluted into a detecting and measuring unit. Carrier-gas flow rate and analyzer temperature are both closely controlled to provide stable, reproducible results. Source: **Perkin-Elmer Corp., Danbury Rd., Norwalk, Conn., U.S.A.**

•

Filter-separator combine

. . . promises removal of all free water and microscopic solids from gasoline, jet fuel, diesel fuel, gases, and air. Tradenamed Fuel-Guard, the product attaches to conventional fuel-dispensing pumps between the hose and the pump to filter out all free water, scale, and small particles. Source: **Warner Lewis Co., 2929 E. Apache, Tulsa, Okla., U.S.A.**

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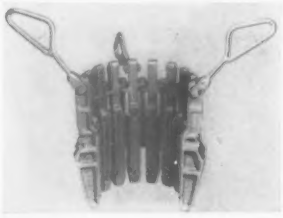
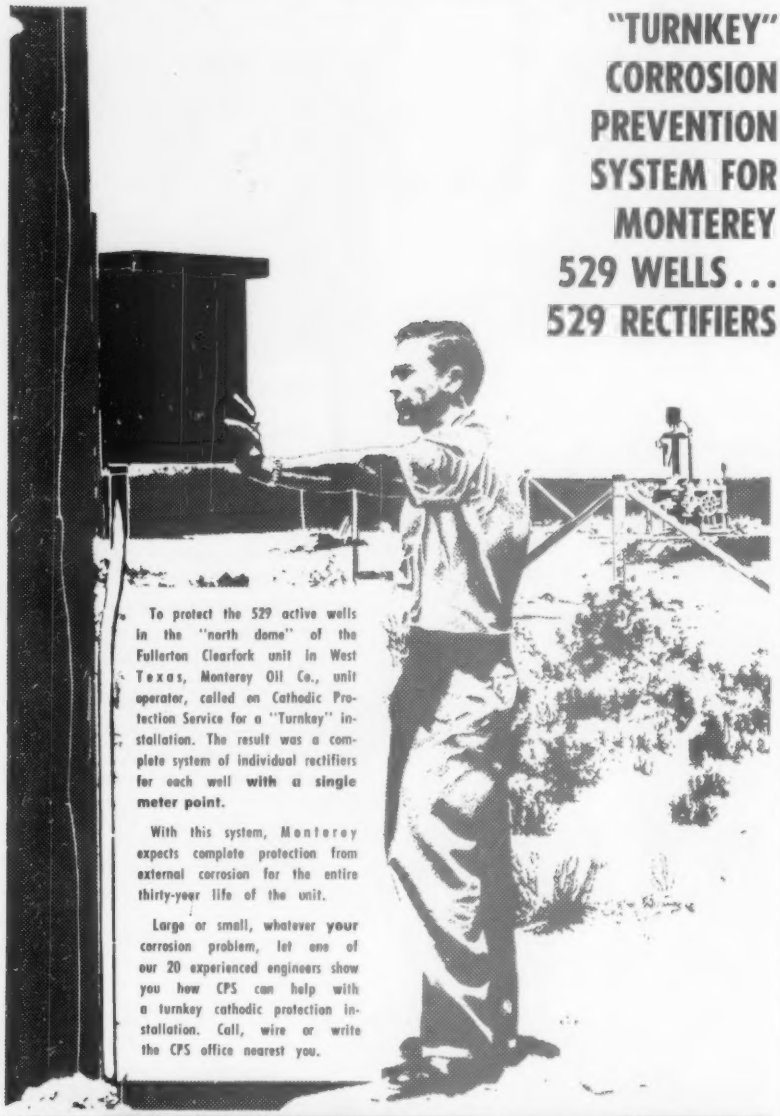


Drill-collar slip

. . . adjusts automatically on collars. A self-aligning, multisegment type, the Type A slip is said to compensate for collar wear in two ways. First, the multisegment design wraps the slip firmly around the collar. Second, sectional inserts adjust vertically to any drill-collar irregularities.

Another feature cited for the slip is that the handles are located low enough to clear elevator travel yet not drag the rotary table. The slip comes in three sizes from 4½ to 5¾ in. up to 6¾ to 8¼ in. Source: **Woolley Tool & Mfg., Inc., 5621 Andrews Highway, Box 2549, Odessa, Tex., U.S.A.**


"TURNKEY" CORROSION PREVENTION SYSTEM FOR MONTEREY 529 WELLS... 529 RECTIFIERS
To protect the 529 active wells in the "north dome" of the Fullerton Clearfork unit in West Texas, Monterey Oil Co., unit operator, called on Cathodic Protection Service for a "Turnkey" installation. The result was a complete system of individual rectifiers for each well with a single meter point.
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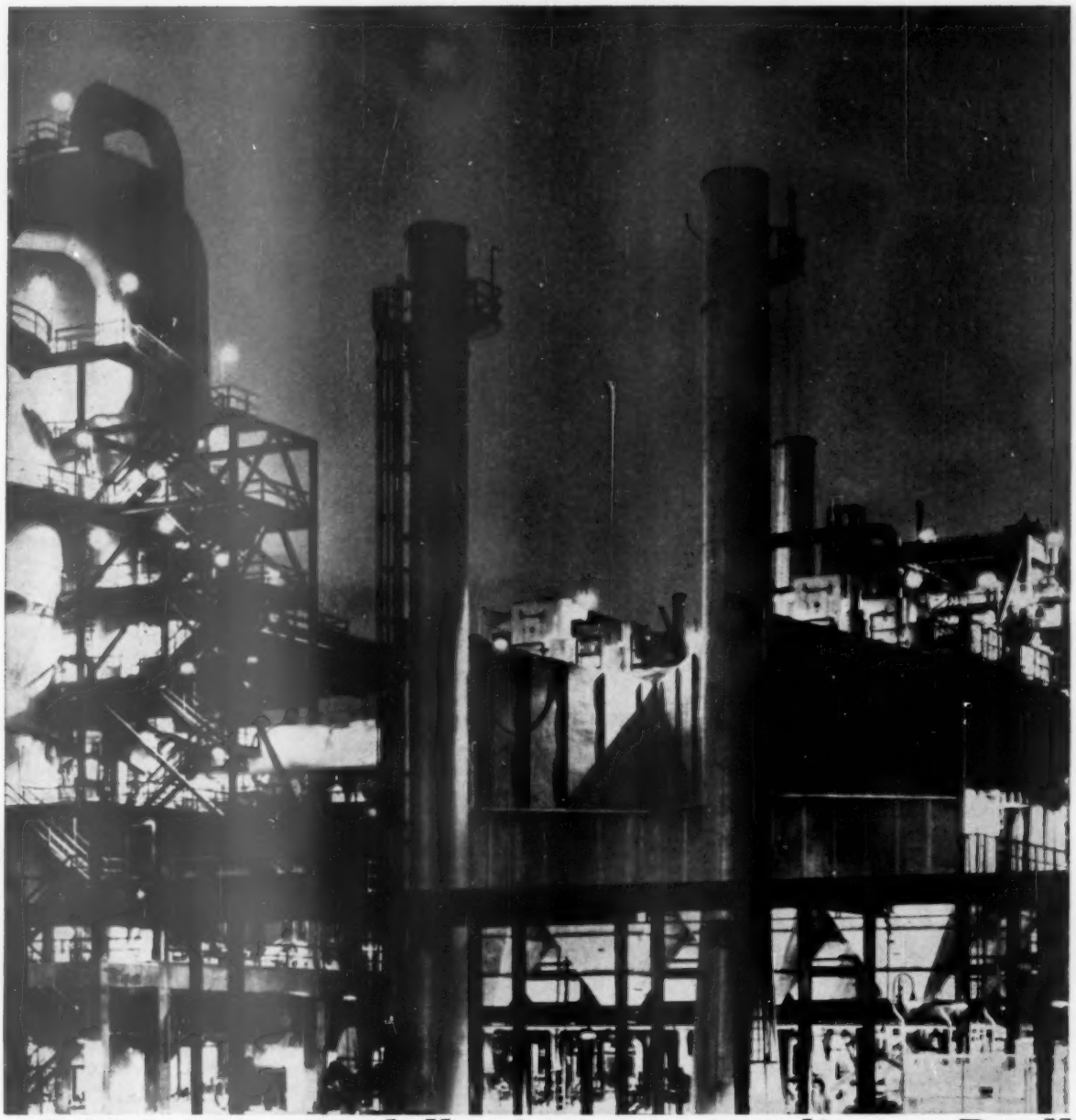

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In a fluid cat cracker an efficient catalyst recovery system is an essential part of the refining process. Improper functioning of the recovery system would require a complete shutdown of operations. In this critical service 80% of our cat cracking capacity relies on Buell Cyclone Systems. Dust recovery and control is vital to many other industrial processes. If sound economics demands continuous operation of your process, make sure you safeguard your investment with Buell-Norblo equipment. It's designed for continuous service without interruption. Buell Engineering Company, Inc., Dept. 61-D, 123 William St., New York 38, N. Y. Northern Blower Division, 6405 Barberton Ave., Cleveland, O.

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• Electric Precipitators • Cyclones • Bag Collectors • Combination Systems • Fans • Classifiers

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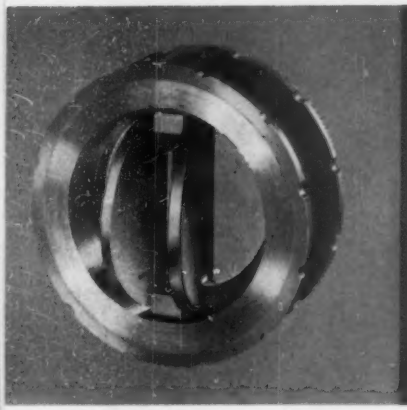
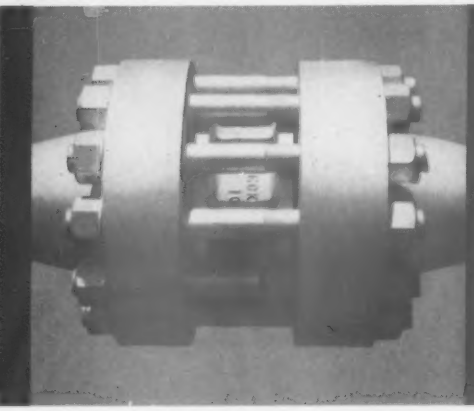
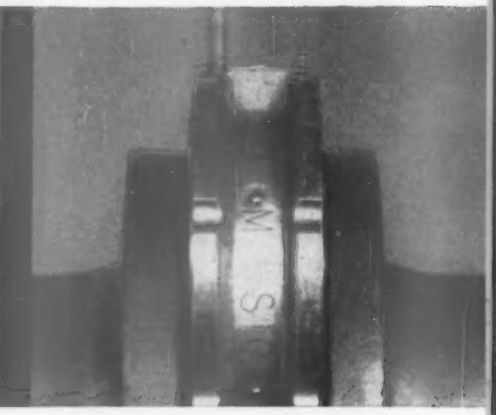
COSTS LESS—WEIGHS LESS—EASY TO INSTALL



Because of its sound, imaginative design, the Duo-Chek check valve is smaller, uses less material, and costs less to buy. It costs less to maintain and lasts longer, too.

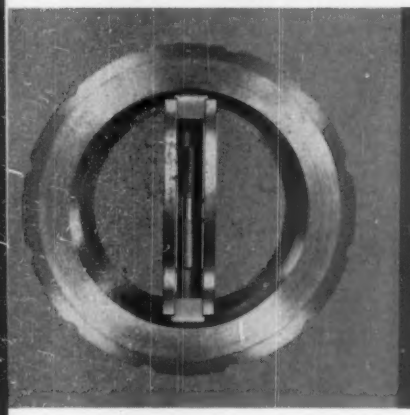


A Duo-Chek check valve weighs on the average less than ten per cent, with some models weighing only two per cent, as much as conventional check valves for the same service. No foundations are needed.

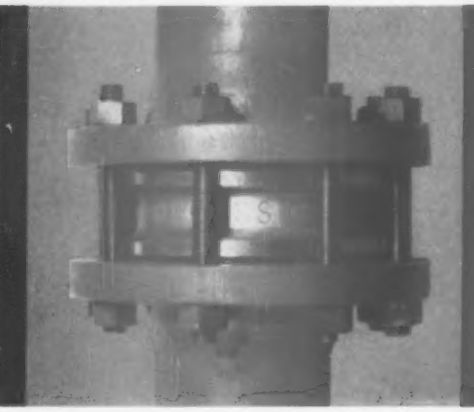


The Duo-Chek fits between the flanges, is smaller and weighs less. For example, a 6-inch steel valve, series 300, weighs 29 lbs., requires no special installation equipment.

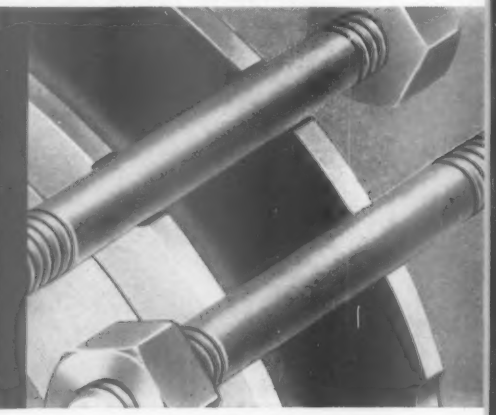
NO SLAM—ANY POSITION—CUTS INVENTORY



A stainless steel coil spring effects positive sealing action. The quick action of the spring closes the valve before reverse flow can occur. Result: No slam, no water hammer.



The Duo-Chek simplifies piping arrangements. The spring loaded plates operate in any position. Most popular sizes can be installed even in vertical lines with downward flow.



The unique versatility of the Duo-Chek greatly reduces inventory. In sizes 2 through 12 inch, one valve fits both series 150 and 300 flanges; 2- and 3-inch sizes fit series 600, too.

MISSION **DUO-CHEK** CHECK VALVE

The Mission Duo-Chek® check valve performs all regular check valve duties, yet is smaller, lighter, and easier to install. Duo-Chek check valves are available in a complete range of sizes from 2 to 48 inches, ASA Series 125 through 2500. They come in various end connections, such as raised face, ring joint, weld neck, etc. They are made in carbon steel, stainless steel, aluminum, and bronze. Special alloys are available. Because of the small size of the Duo-Chek, special alloy valves cost much less than conventional valves in the same alloy.

Sealing material is bonded in a groove in the plate. The sealing material makes an O-ring seal, which pressure deforms until metal-to-metal contact is made by the plate and body seat. Sealing material may be Buna-N, Teflon, Viton, or metal, depending on the service.

The simplicity of design of the Duo-Chek pays off in every installation with longer life and less maintenance. Only six parts are contained within the body of the Duo-Chek, held without the use of internal fasteners or joints of any kind. All parts are interchangeable.

The Duo-Chek is much lighter in weight than conventional check valves, yet is stronger. By dividing the opening, the unsupported plate area is reduced so that each plate requires only one-eighth of the weight of a conventional clapper of the same strength. The short stocky body is inherently stronger and more rigid than a short length of heavy wall pipe.

Whatever your check valve application, the Mission Duo-Chek can cut initial purchase and installation costs, cut maintenance costs from then on. Contact Mission now for a representative.

MISSION VALVE AND PUMP CO. A SUBSIDIARY OF MISSION MANUFACTURING CO. P. O. Box 4209, Houston, Texas • Cable Address 'MISSCO' • Export Office: 30 Rockefeller Plaza, New York • In the United Kingdom: MISSION MANUFACTURING CO., LTD., 1 Hanover Square, London W. 1 England • Cable Address 'MISSOMAN' • Sold by Mission Manufacturing Company outside of Canada and the U.S.A.

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SHOWCASE . . .

New Literature

Centrifugal pumps

. . . of the Model 3405 series of single-stage, double-suction type, are outlined in new 16-page Bulletin 721.6. It shows 34 sizes now available to provide capacities from 100 to 6,400 g.p.m. with heads up to 525 ft. The bulletin presents features, specifications, and interchangeability chart, performance curves, and dimensions. Source: **Goulds Pumps, Inc., 219 Black Brook Rd., Seneca Falls, N. Y., U.S.A.**

Chemical cleaning

. . . of boilers, auxiliaries, and heat exchangers is the topic of a 12-page technical booklet, complete with photographs, now obtainable. It discusses the importance of chemical cleaning of efficient operation and extension of useful service life of various types of power-plant operating equipment. Source: **Dow Industrial Service, 20575 Center Ridge Rd., Cleveland 16, Ohio, U.S.A.**

Rotary compressor

. . . Bulletin ACO 100.4 (20 pages) describes a new compressor for general-purpose services, including those requiring delivery of oil-free air, gas, or vapor. The bulletin lists performance coverage—capacity up to 21 M.c.f.m. and pressure to 250 psig. Source: **Compressor Div., Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Ill., U.S.A.**

Storage vessels

. . . for liquefied-petroleum gases at extremely low temperatures, are outlined in a new 16-page brochure G-50—entitled "Cryogenic Storage Vessels"—recently published. It describes design of double-wall storage vessels, insulation systems, materials of construction, and accessories. Source: **Chicago Bridge & Iron Co., 332 S. Michigan Ave., Chicago 4, Ill., U.S.A.**

Gas odorants

. . . warning agents for natural and LP-gas, are discussed in an available 24-page technical bulletin. The

NEW DUCTILE IRON BODY

CATAWISSA "502" CHECK VALVES

1000 psi OWG 3000 psi Test
Sizes: 2" thru 4" N.P.T.

- COMPACT
- EFFICIENT
- ACCESSIBLE
- EASY TO INSTALL
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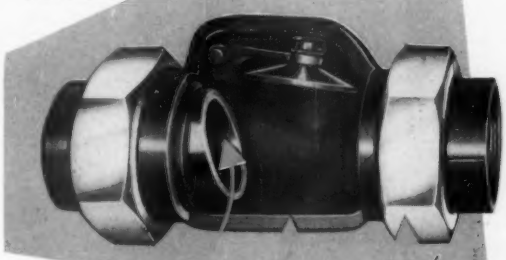
for general flow line and pipeline use . . . horizontal or vertical



Here is one valve designed to take the rough handling necessary in most applications!

Metallographic structure of the ductile iron body resists leakage or seepage of liquids or gases.

FULL OPENING
DUCTILE IRON BODY
ASTM Spec. A-105, Grade 2, Forged Steel Union Ends

In production, pipeline or refinery use—the "502" has earned a reputation for long-life service and satisfaction . . . and now it's a better valve, a better buy than ever!

Catawissa "502" Check Valves withstand severe service conditions with built-in resistance to wear, shock or elevated temperatures. Their resistance to oxidation and a wide variety of corrosive media make them especially valuable where corrosion is a factor. Get the full story on all of their extra-value features!

There's no need to "beat a path to our door" . . . just write for Catalog 60 or call your favorite supply store!

CATAWISSA VALVE & FITTINGS CO.

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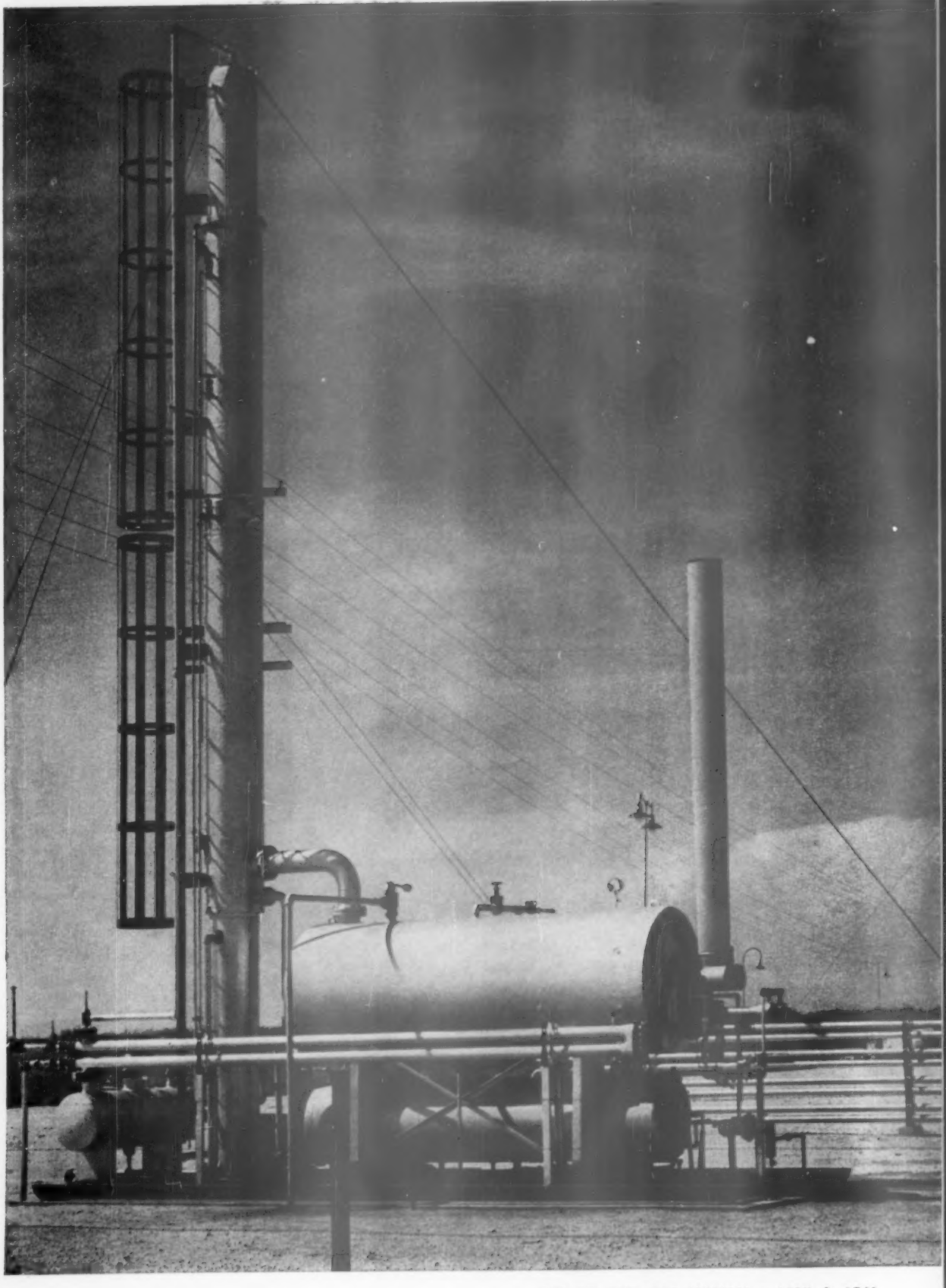
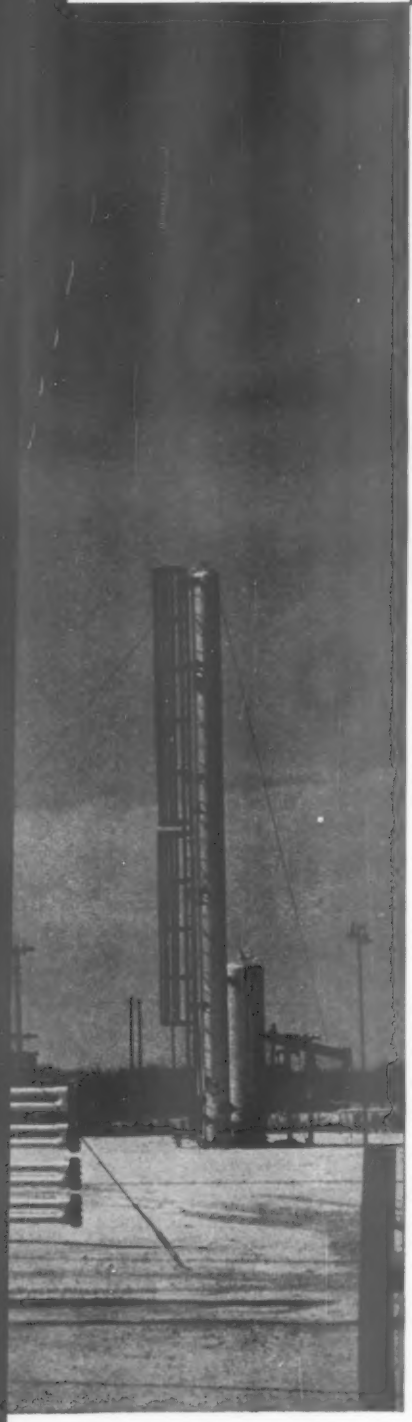


DOW petroleum industry chemicals

GAS PROCESSING



TROUBLE SHOOTERS FROM DOW HELP SOLVE SWEETENING PROBLEMS

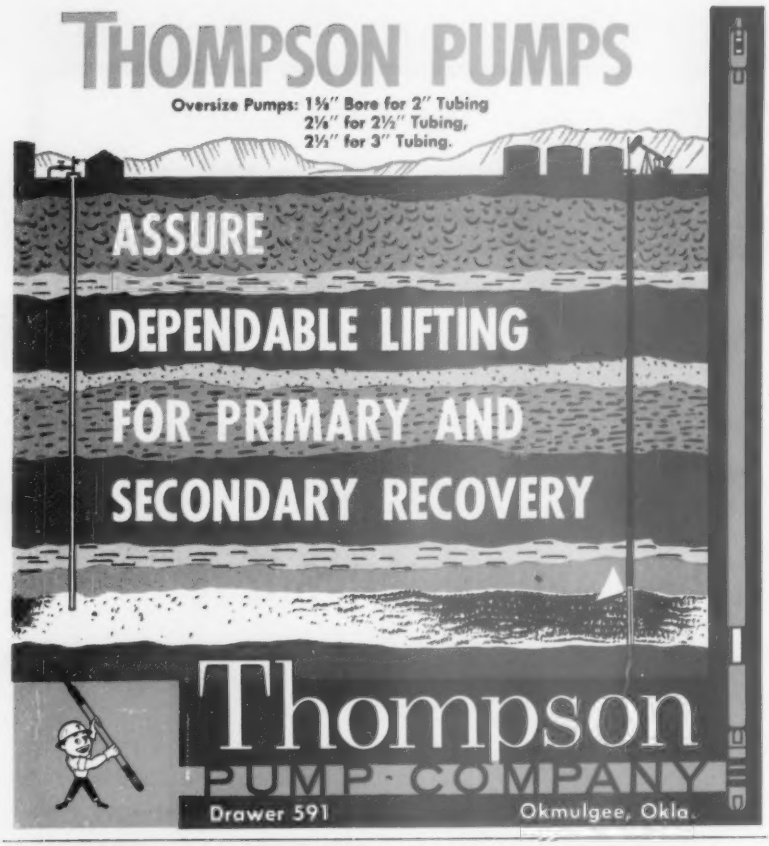
When you're caught by a sweetening problem, and the danger of corrosion, contamination, foaming, or vaporization—call Dow technical service!

You'll find trouble shooters from the Dow Gas Conditioning Laboratory ready to help with a fast, efficient analysis of your problems . . . on-the-spot assistance for corrosion, neutralization, scrubbing problems involving chemicals . . . free amine sample service to all companies engaged in gas processing.

Dow gas processing research and development is continually turning up improvements in processing operations and laboratory techniques. Many of these offer cost reductions, faster, improved analytical techniques and other benefits. Dow provides gas processors with a wide selection of alkanolamines, tailored to fit the individual requirements of sour-gas purification operations. Fast, efficient delivery is assured from Dow's plants, terminals and distributors.

For assistance in any problem, or for complete step-by-step procedures for setting up your own testing facilities, get in touch with the nearest Dow sales office, or contact Dow in Midland.

THE DOW CHEMICAL COMPANY DOW Midland, Michigan



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ON-THE-SPOT AVAILABILITY OF RINGS KEEPS YOUR LINES "ON STREAM"
Dependable performance in all oil and gas applications
Koppers Piston Rings are now available in the field in a complete range of materials and a wide selection of types and sizes for every application in the oil and gas industry
For trouble-free performance, lower operating costs, less down-time, select Koppers Piston Rings—choice of many original equipment manufacturers.
Koppers Piston Ring dependability, in even the most rugged applications, is backed with 38 years of experience in manufacturing rings of predictable performance.
If you have a ring problem, consult your Koppers field agent or write: Koppers Company, Inc., Piston and Sealing Ring Department, 6604 Scott Street, Baltimore 3, Maryland.
Send now for Koppers recommended Piston Ring Set-Ups applicable to the engines which you operate.
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INDUSTRIAL PISTON RINGS
Engineered Products Sold with Service

report, highlighting a special section on odorization, covers such subjects as types of odorizers, storage and transfer of odorants, control of nuisance odors, and methods and equipment used in checking odor intensity. The bulletin also provides a concentrated report on the desirable properties of odorants. Source: **Oronite Div., California Chemical Co., 200 Bush St., San Francisco, Calif., U.S.A.**

Safety grating

. . . of single-piece construction, made of steel, aluminum, and stainless steel, is featured in a new 24-page brochure just published. It includes sections on load charts, how to specify, stair treads, anchoring devices, work platforms and adjustable legs, and fastening methods and devices. Source: **Globe Co., 4000 S. Princeton Ave., Chicago 9, Ill., U.S.A.**

Scale-dissolution rates

. . for sulfamic acid cleaners, plus a diagram sheet showing simple equipment-cleaning hookups are presented in a new booklet. Main advantages of the cleaners are their efficiency, ease of handling, and safety to personnel and equipment, according to the publication. Even at high temperatures, sulfamic solutions give off no fumes. Source: **E. I. du Pont de Nemours & Co., Inc., 4147 du Pont Bldg., Wilmington 98, Del., U.S.A.**

New sieve shaker

. . . called "TESTshaker," is designed for manual operation or gasoline-driven where electricity is not available or electrically driven with a ¼-hp. motor, as described in an obtainable two-page bulletin. The literature offers photos, models available, advantages, and specifications. Source: **Testlab Corp., 3398 Milwaukee Ave., Chicago 41, Ill., U.S.A.**

Power positioner

. . . an electrical/mechanical unit called "Hanna-Powr," can be used to automatically position many types of mechanical devices regulating machine tools, valves, floats, etc., at any of several predetermined positions corresponding to a remote-control selector-switch signal, ac-

New Literature

cording to Bulletin 500A. Forty-eight illustrations, line drawings, and charts, contained in the 10-page bulletin, show how to apply the positioner to air-hydraulic power cylinders, motorized screw drives, and other regulating devices. Source: **Hanna Engineering Works, 1765 Elston Ave., Chicago 22, Ill., U.S.A.**

Helicopter models

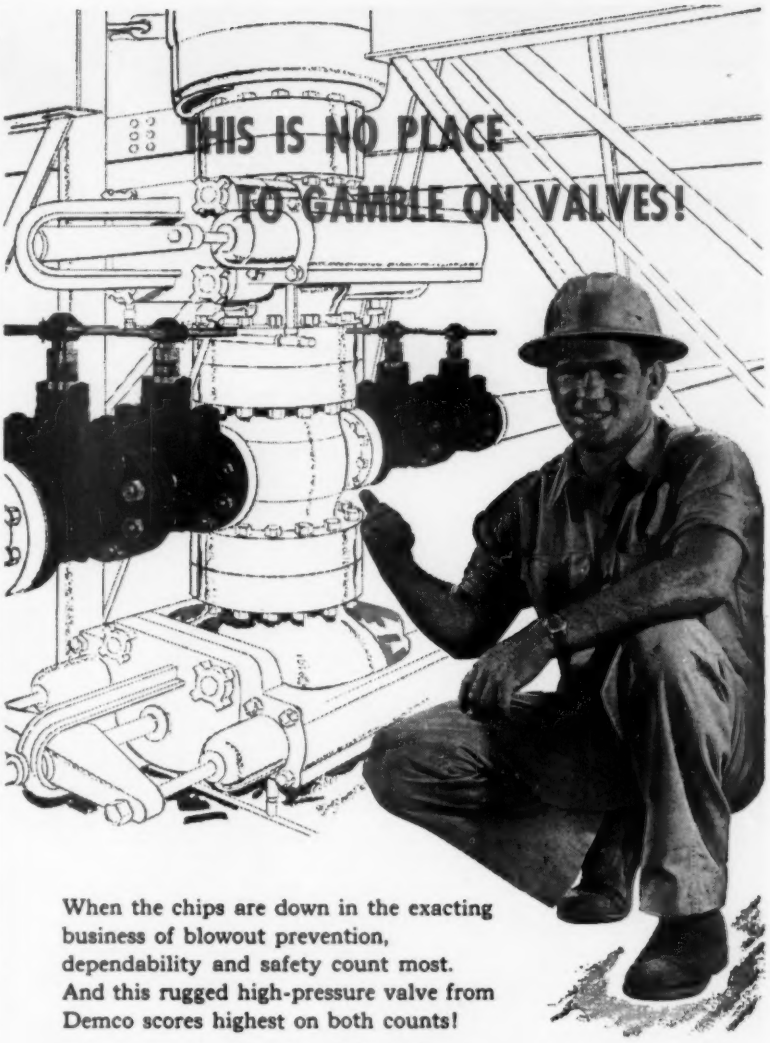
. . . are shown in a new literature piece, obtainable upon request, which covers three and four-place helicopters and their supplementary kits that are said to enable users to increase horsepower and performance characteristics to fit their particular requirements. The 12-page folder gives specifications and comparative performance charts, along with a variety of applications involving both personnel and cargo transportation. Source: **Hiller Aircraft Corp., Palo Alto, Calif., U.S.A.**

Ammonia production

. . . by means of steam reforming is described in a new 12-page brochure just published. It presents direct operating costs and utility unit costs for ammonia production using the Kellogg process in five different sections of the U. S. The brochure includes process descriptions and flowsheets for the basic ammonia process and for both one and two-stage steam-reforming operations. Source: **M. W. Kellogg Co., 711 Third Ave., New York 17, N. Y., U.S.A.**

New template catalog

. . . carries photographs and descriptions of 115 templates now being made. Divided into eight sections, Catalog 65 shows templates for use in various fields of engineering. Eleven templates are for use in general design and structural shapes. Included are processing templates for use in chemical and instrumentation fields, along with a computer diagraming template and a series of fluid-connection templates. Source: **Rapidesign, Inc., Box 429, Burbank, Calif., U.S.A.**



When the chips are down in the exacting business of blowout prevention, dependability and safety count most. And this rugged high-pressure valve from Demco scores highest on both counts!

The rugged construction of the Demco Valve assures its reliability—it *holds every time* against the high pressures of an unexpected flow. You get a positive rubber-to-metal seal without applying undue torque to the stem—a drop-tight seal that you can depend on.

And no matter when you need it, the Demco valve will always operate easier. Fewer parts are subject to wear. Stem threads are constantly self-lubricated and are protected from abrasives with *double* stem seal.

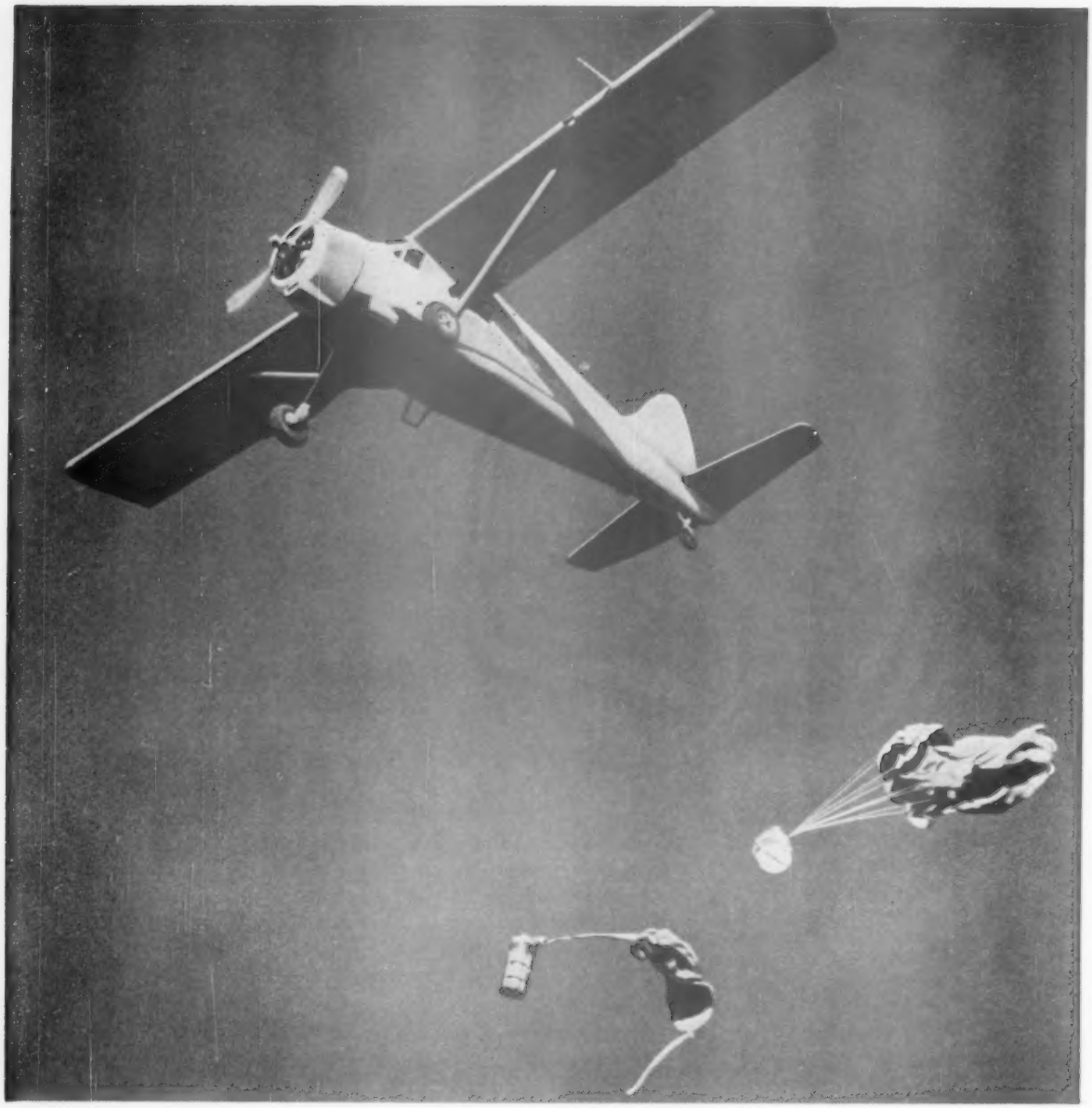
When you choose a valve for blowout prevention application, choose reliability, rugged construction and sure-seal safety. Choose Demco!

Available at supply stores everywhere in 1,000, 2,000, 3,000 and 5,000 psi working pressures . . . in two- to four-inch sizes.

DRILLING EQUIPMENT MANUFACTURING CO.

845 S. E. 29th Street ● OKLAHOMA CITY

DEMCO



Airlift Australia

AUSTRALIA'S Snowy Mountains Scheme has presented some unusual challenges to BP as sole supplier of petroleum products. Some of these challenges have been met in unusual ways, such as fuel drops from aircraft.

This gigantic project, midway between Sydney and Melbourne, with its great dams, power stations, and miles of tunnels and aqueducts, is designed both to provide hydro-electricity and to divert irrigation water westwards into the parched plains.

British Petroleum is proud to be associated with the Snowy Mountains Scheme, one of the world's greatest engineering undertakings.

BP

▶▶▶ Equipment Men Notes

Clyde Lackey named manager . . . of Cabot Corp. Machinery Division's newly selected export sales division at Houston, according to Clair Simmons, director of sales and service. Lackey was formerly sales manager at Pampa, Tex. For the last several months, Lackey has been establishing new dealers in South America, Mexico, and Europe, in an effort to expand Cabot's export program.

Clyde Lackey

Crane Co. forms new division . . . to service and repair valves, with plants and offices located throughout the country. The first valve-repair facilities are now in operation in Chicago and Houston. A plant in Los Angeles is scheduled to open later this month.

Oil Tool Mfg. Co., Inc. announces . . . new plants in Calgary, Alta. which will operate entirely independent of the Tonkawa, Okla. firm. A. L. Consay will be president and general manager. The 70 by 100-ft. plant and an adjoining 75 by 16-ft. office building have been constructed. For the present, the plant will fabricate only seismograph rock bits ranging in size from 4½ to 5⅛ in., and an insert blade bit. Monthly production will be about 500 bits.

C. W. Williams, president of Oil Tool, also announced that a plant in Mexico City is under construction to build bits from components fabricated in Tonkawa.

Oil Center Tool Co. appoints . . . Louis Early as a sales-service representative at Odessa, Tex. He was previously a warehouseman at Shreveport. With headquarters in Houston, O-C-T manufactures wellhead equipment.

Wm. T. Havron named manager . . . of industrial sales for the New Orleans district of Allis-Chalmers Industries Group. He succeeds Hugh C. Blair, recently named manager of the Phoenix district. Havron has been a sales representative in Allis-Chalmers' Birmingham, Miami, Atlanta, and New Orleans districts. He joined the company in 1951.

Hughes Tool Co. elects three . . . members of its Oil Tool Division to the board of directors, according to M. E. Montrose, senior vice president and general manager. New board members are: Park L. Myers, assistant vice president of sales; Lyle L. Payne, assistant vice president of engineering; and Arthur H. Wooler, assistant vice president of manufacturing.

P. L. Myers

Myers joined Hughes in 1940 as a field salesman. He held a number of managerial positions in sales and was made assistant vice president of sales in 1959. Payne joined Hughes in 1930 and served in many engineering capacities, including chief engineer. He was promoted to assistant vice president of engineering in 1952. Wooler started with the company in 1947 as assistant chief industrial engineer. Three years later he was appointed chief industrial engineer, and in 1955 became assistant vice president of manufacturing.

L. L. Payne

A. H. Wooler

Grant Oil Tool Co. names three . . . drilling-equipment sales and service firms to represent the company in French, Middle East, and Argentinian oil fields, according to A. H. Salvatori, Grant vice president.

S. N. Marep, of Paris, will represent Grant in France, North Africa, and the Franc area countries. Macridge Petroleum Equipment Supply Co., of Beirut, will sell and service Grant tools in Lebanon and

EQUIPMENT MEN HONORED with "Citation for Service" awards from the southern district of American Petroleum Institute. From left are: Lloyd A. Little, Lufkin Foundry & Machine Co., for API standardization work on production equipment; George R. Gray, Baroid Division of National Lead Co., for API drilling fluids effort; and Gage Lund, API vice president for production, and vice president of Standard Oil Co. of California, who made the presentations.

Survey party sets out in the all-wheel-drive Scout: Plenty of room for both crew and working gear! All steel Travel-Top (optional) makes pickup box weather-tight. The Scout strips down—cab top, windows, doors come off in minutes. Less than 13 ft. overall on a 100-in. wheelbase, only 68 in. wide and 68 in. high. Powered by new COMANCHE 4-cyl. 90 hp engine.

Shot hole drill-rig crew follows up: They get the job done with the rugged INTERNATIONAL model RF-190 six-wheeler. This rig can drill through bedrock, taking poundings that literally lift it off the ground. Heavy, varying or surging loads are all in a day's work for the truck-built clutch and transmission.

Explosive and sound-recording crew moves in: INTERNATIONAL model B-160 is versatile enough to haul the explosives, yet solid enough to carry and care for the delicate instruments in the recording cab. Whether standard V-8 or optional Six, the engines are all *truck-designed.*

Explore Anywhere with this geophysical team

Now, with the new Scout® by INTERNATIONAL, you have a transportation team that's...

Mobile: It's rough running a string of holes, but this gutsy INTERNATIONAL team can't be stopped by any terrain!

Powerful: Best power-to-weight ratios yet engineered – for delivering fast drilling power to promising ground!

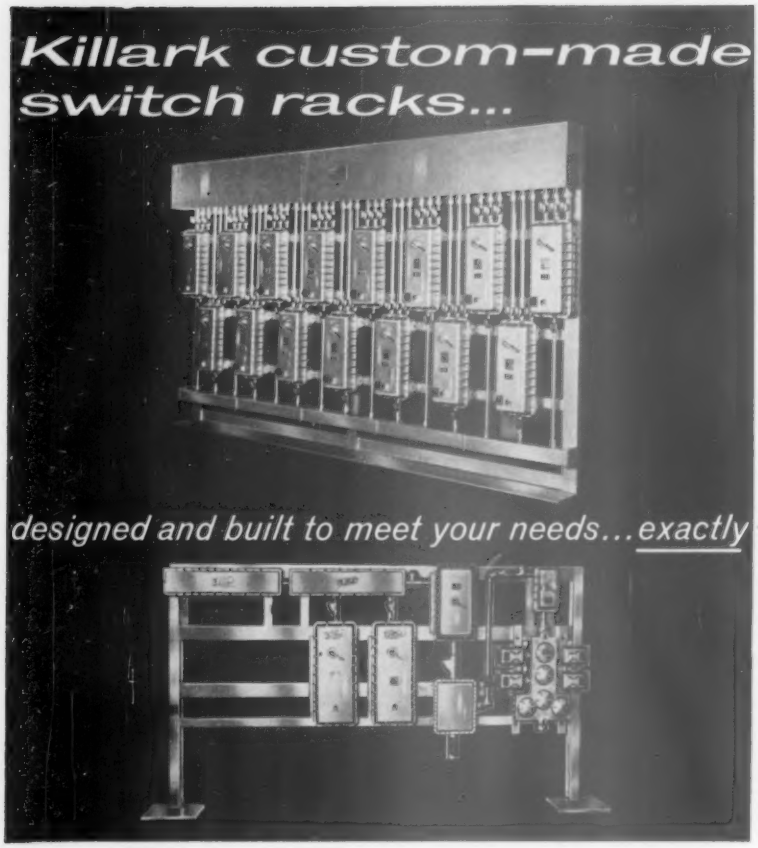
Enduring: They stay on the job, stand up to full throttle—even when drilling through bedrock!

Put this proven INTERNATIONAL truck team to work with your crews! And remember, INTERNATIONAL equipment is backed by sales and service centers across the country, plus 12 major parts depots. This means less "downtime"—resulting in doodle-bugging days that are faster-striking and less costly.

INTERNATIONAL® TRUCKS IH®

WORLD'S MOST COMPLETE LINE

International Harvester Company, Chicago



Your worries are over from the moment you choose Killark custom-made switch racks because Killark provides a complete service — design to assembly. First, Killark prepares and submits a preliminary blueprint of the entire unit, drawn to your specifications. After approval, the switch rack is assembled, wired, and sealed *at the factory* by Killark workers with experience and equipment to do the job right. You receive a switch rack ready to install.

The two racks shown are examples of the type of custom-made units Killark can provide. Each has been made to meet the users exact specifications, and is completely pre-wired and pre-sealed. Killark's rust-proof, non-sparking *aluminum* enclosures have been used throughout the assemblies to give added years of trouble-free performance.

You get these extras when you order Killark custom-made racks:

Services of expert Killark engineers • One supplier for all components • Dependable Killark aluminum enclosures • Fast delivery • Easy installation.

Racks for outdoor or indoor, hazardous or non-hazardous locations. Write for complete literature.

Killark
ELECTRIC MANUFACTURING CO.
Vandeventer and Easton Aves. • St. Louis 13, Mo.
Sales Representatives and Warehouse Stocks in Principal Cities

6021

Killark Supplies Everything But the Current!

the Middle East. Argentine representative is Drillex, of Buenos Aires.

These representatives will facilitate deliveries and service for Grant's line of reamers, stabilizers, hole enlargers, and other down-hole tools. They also will provide liaison between customers and Grant engineers when special needs or drilling problems arise.

Baroid Division announces

... a series of appointments and transfers. K. K. Litman, former manager of the East Louisiana Gulf Coast area, has been appointed

K. K. Litman

L. T. Weber, Jr.

manager of the newly formed Louisiana Gulf Coast area which includes the districts of Houma, New Orleans, Lake Charles, Lafayette, and Berwick. Headquarters is in New Orleans.

L. T. Weber, Jr., manager,

C. W. Felker

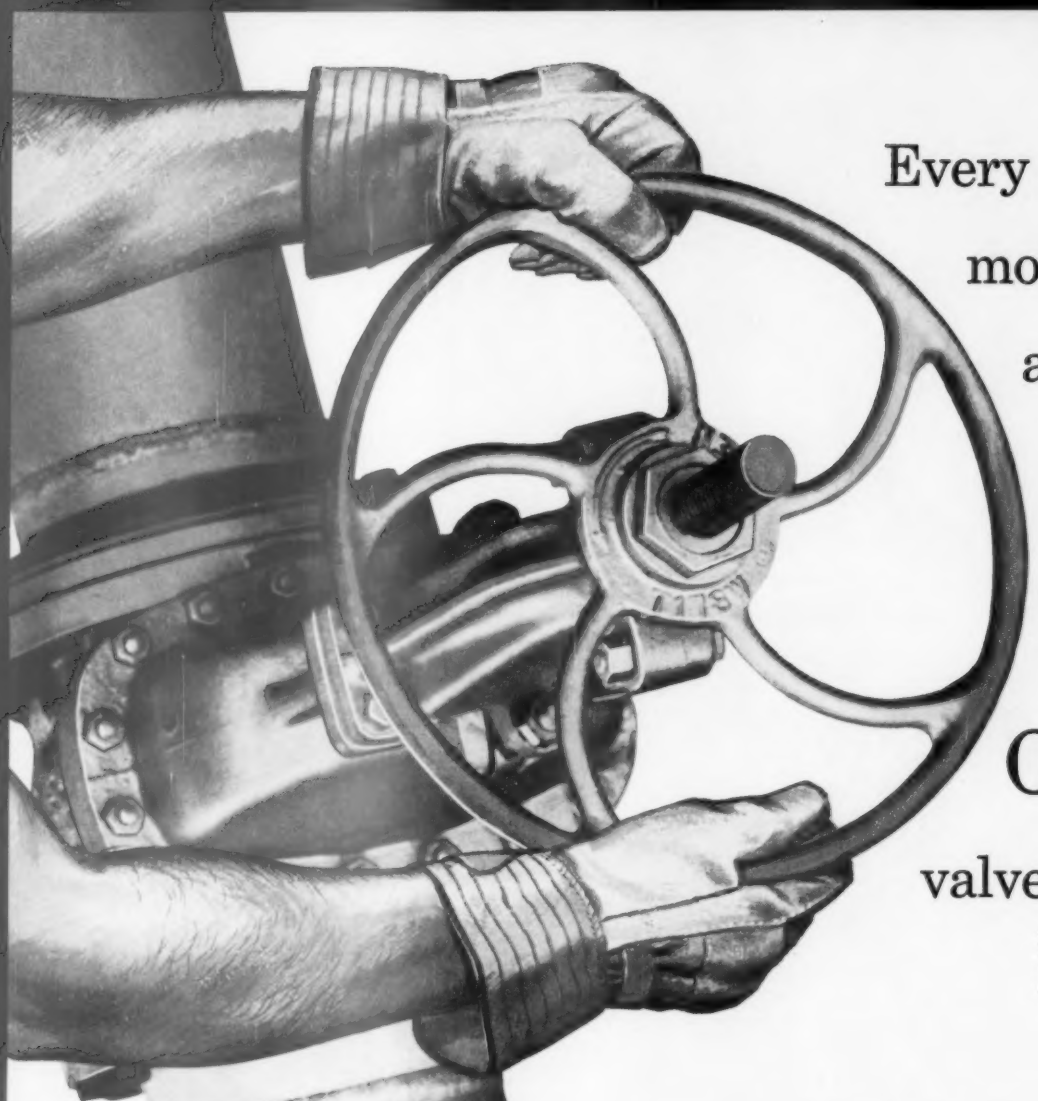
R. E. Killion

Baroid of Canada, Ltd. area in Calgary, has become area sales manager of the Louisiana Gulf Coast and will locate at New Orleans. C. W. Felker is the new assistant

W. D. Watson

S. D. Wiginton, Jr.

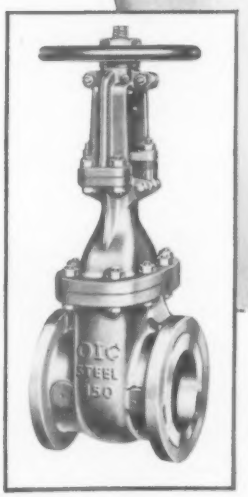
manager of the Louisiana Gulf Coast area with headquarters in Lafayette. R. E. Killion, district su-



Every day... more and MORE oil companies turn to OIC valves

. . . because OIC has developed valves to solve the special problems of the oil and gas industry . . . valves built for continuous operation and lower maintenance cost. A variety of experience-proved materials and designs are available to meet the exacting needs of this industry in the field, in the refinery and gasoline plants wherever oil and hydrocarbons are being produced, processed or transported. Standard valve trims are available for highly corrosive and severe pressure-temperature operating conditions. Get acquainted with your local OIC distributor. He is equipped to help you with all your valve problems.

BETTER VALVES AND BETTER SERVICE FROM OIC DISTRIBUTORS



INDUSTRIAL DISTRIBUTORS
SERVING INDUSTRY ECONOMICALLY
THE RIGHT HAND OF PRODUCTION

OIC VALVES

FORGED STEEL, CAST STEEL, BRONZE, IRON AND DUCTILE IRON VALVES

10218-OIC

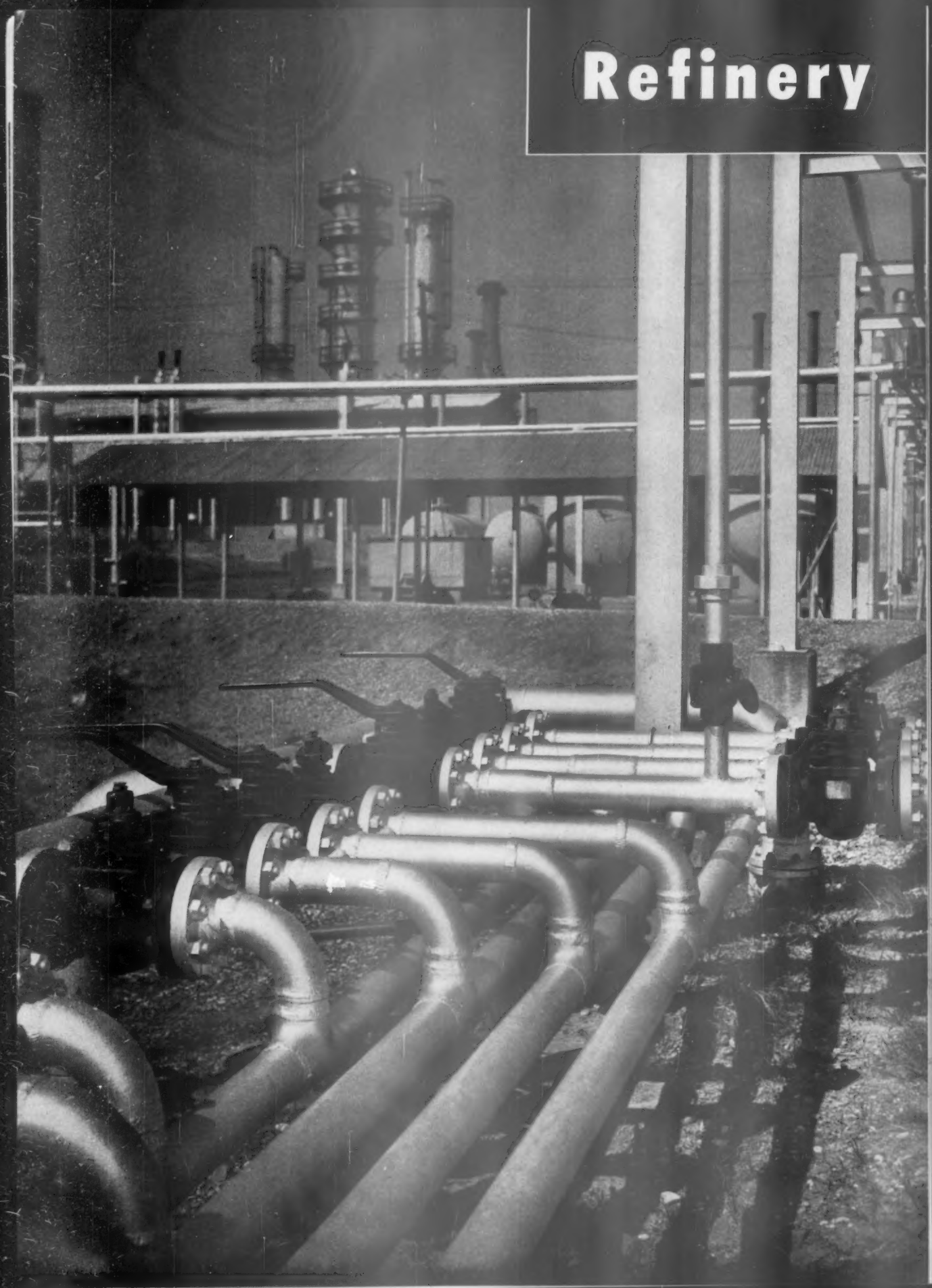
THE OHIO INJECTOR COMPANY
273 Main Street, Wadsworth, Ohio
Please send more information about
Iron ( ) Bronze ( ) Steel ( ) Ductile Iron ( ) Valves.

Name_____

Company_____

Street_____

City_____ Zone_____ State_____


Refinery

Maintenance Made Simple

Here are the quality leaders, the names in refining, natural gasoline and petrochem plant equipment synonymous with performance.

When you specify pipe, valves or welding fittings made by these manufacturers, you know you are getting quality. You know that longer service life and less down time result when quality equipment is installed. We are proud to offer you these quality leaders. We know that the research and development invested in these products mean more satisfied customers for J&L.

You can have up-to-date literature on any of these products by calling your local J&L man.

Specify quality.... and save at J&L.

Jones & Laughlin

SUPPLY DIVISION – Tulsa

If it's sold by J&L....
It's the best available

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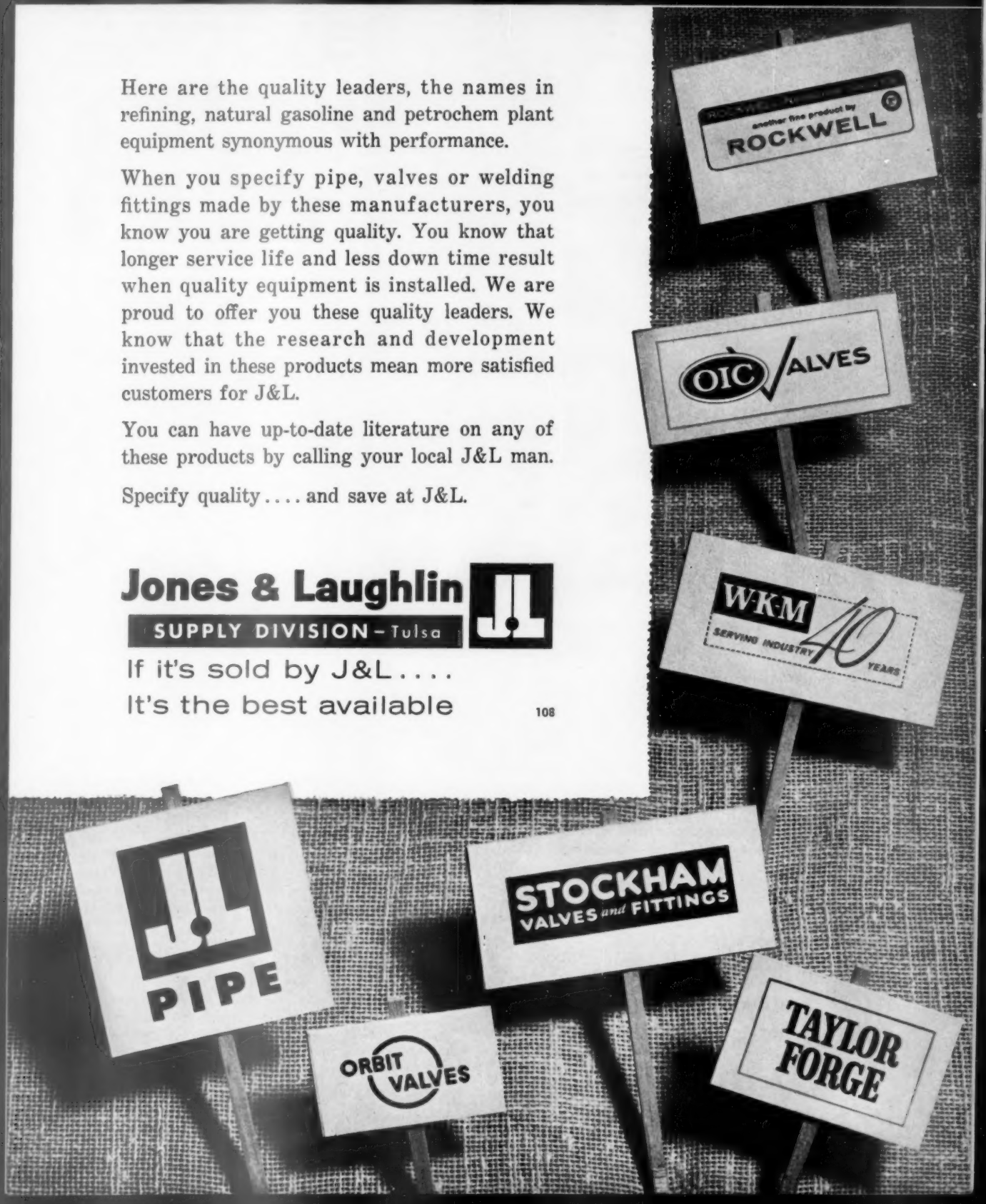
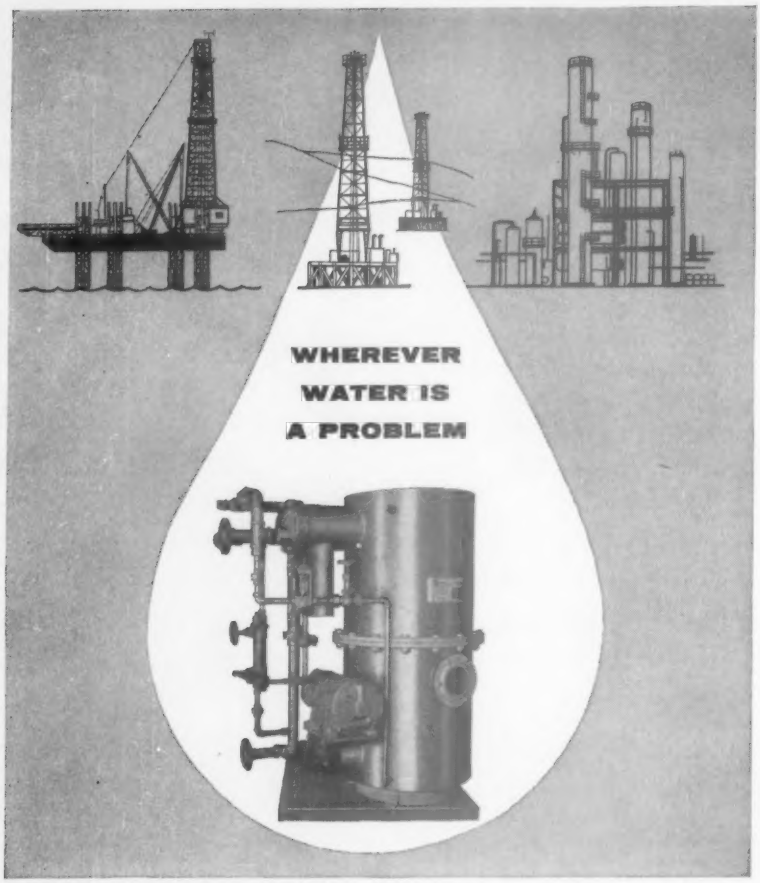




AQUAVAP

HEAT RECOVERY EVAPORATORS

ARE THE FUEL-FREE, LOW COST ANSWER

Sold as a complete packaged unit, low in initial cost, inexpensive to maintain, and simple to operate, AMF-Maxim Aquavap evaporators are ideal for use offshore or on land. They convert salt or brackish water to fresh water, using engine jacket water or any other available hot water as a heat source. Thus their operation is fuel free. Five models are available with capacities ranging from 150 gallons per day up to 12,500 gallons per day. The purity of water produced exceeds U. S. Dept. of Health requirements.

Aquavaps are extremely compact. A unit providing, for example, up to 1,000 GPD is less than 4 feet high and laterally takes only about 2 x 4 feet of floor or deck space. Such a unit would weigh approximately 700 lbs. Other types of AMF-Maxim evaporators are available with capacities ranging from 150 to more than 1,000,000 gallons per day. For further information on the Aquavap, write to our Waterford address below.

AMF MAXIM EVAPORATOR DIVISION
American Machine & Foundry Company
WATERFORD, CONN. • Branch, DENVER, COLO.

Represented by **THE J. S. BEAIRD COMPANY**
Shreveport, New Orleans, Tulsa, Midland, Houston, New York

perintendent at Edinburg, Tex., has been named manager of the Baroid of Canada, Ltd. area, with headquarters at Calgary. W. T. Sherman, sales representative in Houston, takes over as superintendent of the Edinberg-McAllen district.

W. D. Watson, former assistant general sales manager at Houston,

J. M. Bugbee, Jr.

W. C. Kellogg

has become manager of Baroid's West Texas area with headquarters at Midland. S. D. Wiginton, Jr., West Texas area manager, has been transferred to Dallas and appointed sales representative there.

J. M. Bugbee, Jr., assistant manager of the Lower Texas Gulf Coast area in Houston, has been named manager of Baroid's newly formed Tri-State area, comprising East Texas, North Louisiana, and Mississippi, with headquarters in Shreveport. W. C. Kellogg, assistant area manager at Lafayette, has been shifted to Houston as assistant manager of the Lower Texas Gulf Coast area.

American Systems, Inc. forms

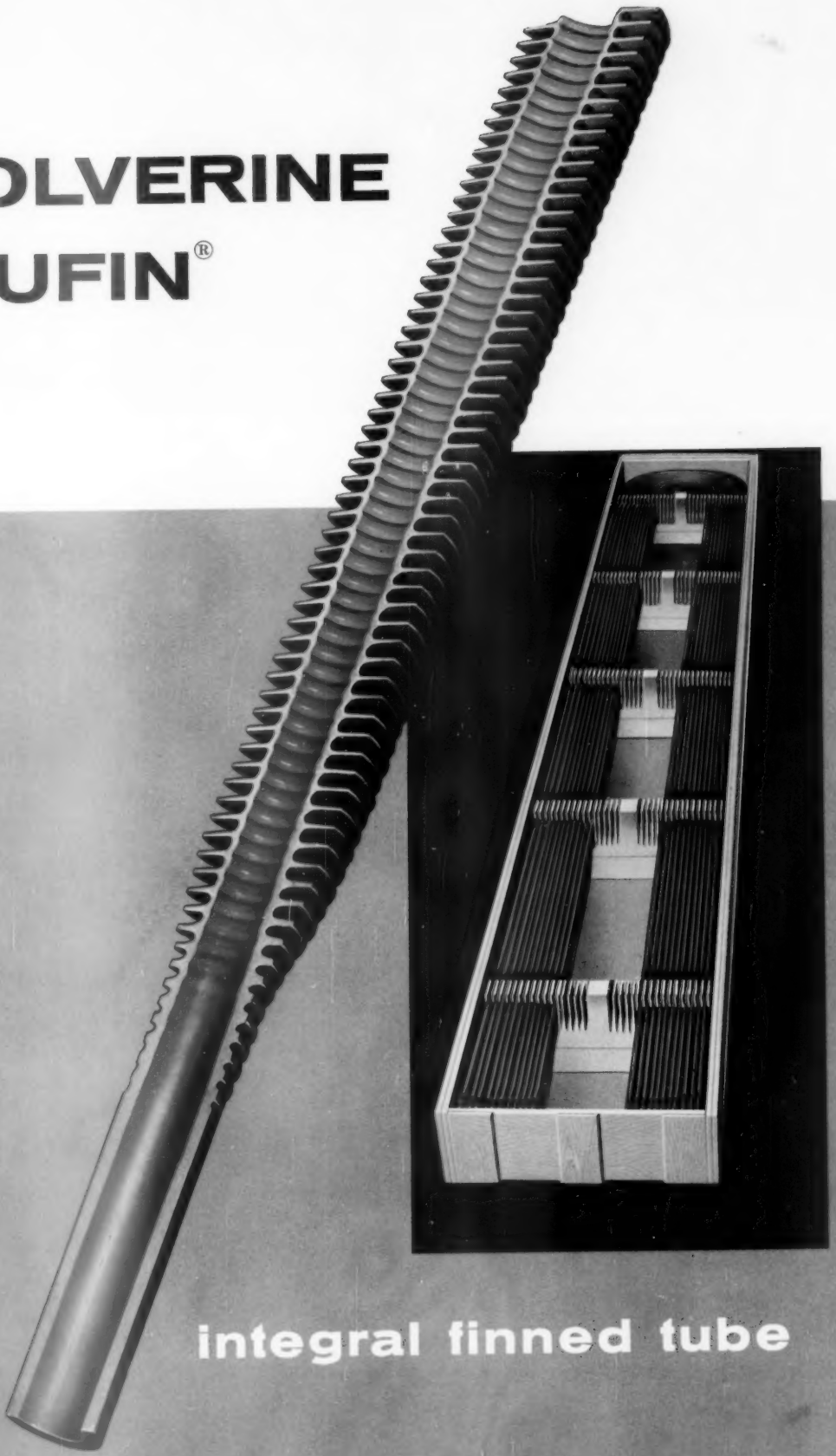
. . . seven operating divisions, some of which previously existed as laboratories. American Systems, of Hawthorne, Calif., is an affiliate of Schlumberger Well Surveying Corp.

The groups will be known as the Instrument Division, Component Development Division, Instructron Division, Information Sciences Division, Electromagnetic Systems Division, Command and Control Division, and Research Laboratories Division. Each unit will be headed by a director, who will be responsible for all technical and administrative functions.

J&L Supply Division becomes

. . . a distributor of hydraulic subsurface pumps manufactured by Johnson-Fagg Pump Co., of Tulsa, and exclusive oil-country distributor for "Fast Line," made by McDowell Mfg. Co., of Pittsburgh. The latter product is used for temporary or

WOLVERINE TRUFIN®



the integral finned tube

New Specifications Data!!

when EXPERIENCE counts —you can count on

WOLVERINE TUBE

Wolverine Tube developed integrally finned tubing (Wolverine Trufin) in 1928 and since that time has been the originator of most of the available information on finned tube technology.

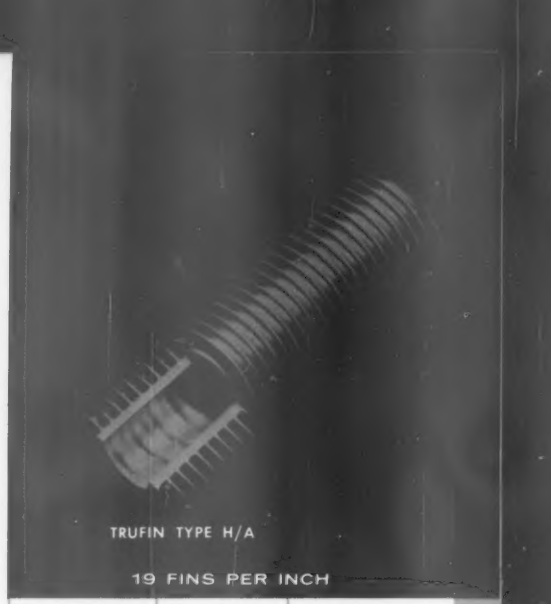
Wolverine research has uncovered the most advantageous applications of Trufin and has developed the various types of integrally finned tube on the market today.

For the past several years, throughout the country's major processing and refining areas, Wolverine has conducted a series of Technical Heat Transfer Seminars under the guidance of the top men in this field.

Wolverine Tube has also given special and extensive heat transfer and integrally-finned tube training to a number of Heat Transfer Specialists who operate on a national basis. The services of these men are available to the heat transfer industry at large. Those desiring specific finned-tube knowledge can also draw on Wolverine's large library of product literature and catalogs.

There is an American business maxim that says *"For qualified guidance you must seek a qualified source."*

You'll find that where integrally-finned tubing is concerned Wolverine Tube is indeed such a source.



TRUFIN TYPE H/A

19 FINS PER INCH

STANDARD SIZES		CATALOG NO.	PLAIN SECTION DIMENSIONS	
O.D.	Wall Thk.		O.D.	Wall Thk.
5/8"	0.028	60-194028	0.625	0.042
	0.035	60-194035		0.049
	0.042	60-194042		0.058
	0.049	60-194049		0.065
	0.065	60-194065		0.083
3/4"	0.028	60-195028*	0.750	0.049
	0.035	60-195035		0.052
	0.042	60-195042		0.058
	0.049	60-195049		0.072
	0.065	60-195065		0.083
	0.083	60-195083		0.095
7/8"	0.035	60-196035*	0.875	0.054
	0.042	60-196042		0.058
	0.049	60-196049		0.065
	0.065	60-196065		0.083
	0.083	60-196083		0.095
1"	0.042	60-197042*	1.000	0.058
	0.049	60-197049		0.065
	0.065	60-197065		0.083
	0.083	60-197083		0.095

WOLVERINE ALLOY CODE

CODE NO.	ALLOY	WT./FT. CONVERSION FACTOR (Wt./Ft. of Copper x Conv. Factor = Wt./Ft. of alloy)
01	Copper	1
02	Arsenical Copper	1
25	Admiralty (Type C)	0.9536
26	Admiralty (Types B & D)	0.9536
28	Red Brass, 15%	0.9780
30	Aluminum Brass (Type B)	0.9319
41	3003 Aluminum	0.3065
57	Low Carbon Nickel	0.9938
51	Cupro-Nickel, 30%	1
53	Cupro-Nickel, 10%	1
58	Cupro-Nickel, 20%	1
60	Low Carbon Steel	.8762

Example: ***Wolverine Trufin type S/T***
Catalog No. 60-195065-26

60	19	5	065	26
TYPE S/T	FINS PER INCH	NOMINAL ROOT DIA. IN 1/8 OF INCH	NOMINAL WALL AT FIN	ALLOY CODE NUMBER

TRUFIN TYPE L/C—BIMETAL

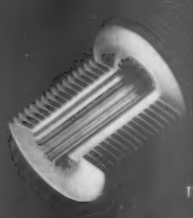
TRUFIN TYPE H/R

TRUFIN TYPE S/T

TRUFIN TYPE S/T—DUPLEX

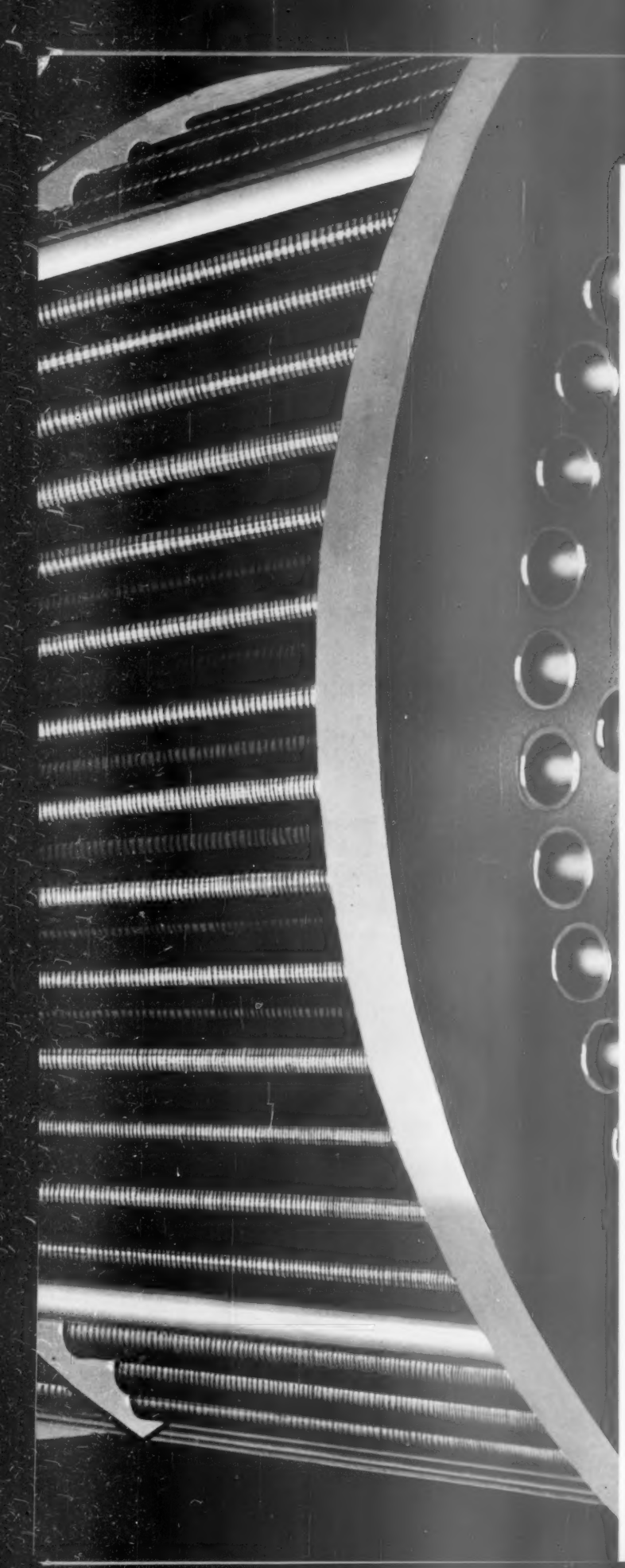
FINNED SECTION DIMENSIONS			OUTSIDE AREA	SURFACE AREA RATIO	I.D. CROSS SECTIONAL AREA	APPROX. WT./FT. LBS.	AVAILABLE ALLOYS
Root Dia.	Wall Thk. (Avg.)	Wall Thk. (Min.)	Sq. Ft. per Linear Ft. (Avg.)	Outside to Inside	In Sq. Inches (Avg.)	(Copper)	(See Wolverine Alloy Code)
0.500	0.028	0.025	0.405	3.48	0.155	0.283	01, 02, 41, 53, 57
	0.035	0.031		3.60	0.145	0.320	
	0.042	0.037		3.72	0.136	0.356	
	0.049	0.044		3.85	0.127	0.391	01, 53, 51, 41, 02, 57, 28, 25, 26, 60
	0.065	0.058		4.18	0.108	0.466	
0.625	0.028	0.025	0.496	3.33	0.254	0.353	01, 53, 41, 57, 02
	0.035	0.031		3.41	0.242	0.401	
	0.042	0.037		3.50	0.230	0.448	
	0.049	0.044		3.60	0.218	0.493	01, 53, 51, 02, 41, 57, 28, 25, 26, 60
	0.065	0.058		3.84	0.192	0.593	
	0.083	0.074		4.13	0.166	0.697	
0.750	0.035	0.031	0.588	3.30	0.363	0.485	01, 53, 02, 41, 57
	0.042	0.037		3.37	0.349	0.541	
	0.049	0.044		3.44	0.334	0.597	
	0.065	0.058		3.62	0.302	0.721	01, 53, 51, 02, 41, 57, 28, 25, 26, 60
	0.083	0.074		3.85	0.268	0.853	
0.875	0.042	0.037	0.678	3.27	0.492	0.632	01, 53, 02, 41, 57
	0.049	0.044		3.33	0.474	0.699	
	0.065	0.058		3.48	0.436	0.847	01, 53, 51, 02, 41, 57, 28, 25, 26, 60
	0.083	0.074		3.65	0.395	1.006	

*Plain lands are available on all standard Type S/T sizes except 195028 and 196035. Lands are limited to a minimum length of one inch.



TRUFIN TYPE I/L

TRUFIN TYPE S/T
U-BEND FOR SHELL AND TUBE CONDENSERS



You can afford to do it better for less

IT'S THAT SIMPLE!

By having your shell and tube heat exchangers and condensers designed around Wolverine Trufin® Type S/T, you actually can, in many cases, afford to replace admiralty tubing with higher grade alloys such as cupro-nickel.

The result is a unit with greater resistance to corrosion and erosion—one that will stay on stream longer with a minimum of maintenance.

The answer, of course, comes from the greatly increased surface area gained by Trufin Type S/T because of its integral fins.

These fins are actually squeezed from the tube wall and give Trufin Type S/T as much as 2½ times more surface area than a comparable piece of plain tube. As a result, you handle more BTU's per foot of tube, thus use fewer tubes, smaller shells, headers and baffles and, in the case of overhead units, less structural support.

For complete information about how Wolverine Trufin Type S/T can help you do a better job for less, just write for your copy of the Trufin Catalog. Or better still—

Ask your Wolverine Salesman.

WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
DEPT. L, 17238 SOUTHFIELD RD., ALLEN PARK, MICH.
TUBEMANSHIP in Copper—Copper Alloys—Aluminum—Special Metals

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
SALES OFFICES IN PRINCIPAL CITIES

PROTECT
YOUR
EQUIPMENT
...SEE THE
NEW
SATELLITE!

See the Garzo, Inc. exhibit of Automatic Oil Level Controls for high pressure feeding of force feed lubricators with Safety Switches . . . at the

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STOP H_2S
CORROSION
BEFORE
IT STARTS!

• The Connelly IRON SPONGE purification process at the well site removes hydrogen sulphide BEFORE the gas is piped to central processing. Thus, the cause of pipe line corrosion is eliminated because corrosive gas never enters the transmission lines. Additionally, Connelly IRON SPONGE eliminates the need for extreme close control. It operates with high efficiency at low or high pressures—absorbs more H_2S, gives longer service between foulings and is easily regenerated. If you have a purification problem check this MOST ECONOMICAL solution today. Write for Field Processing Bulletin #OG-7.

CONNELLY, Inc.
3164 SOUTH CALIFORNIA AVENUE
CHICAGO 8, ILLINOIS
ELIZABETH, NEW JERSEY

semipermanent portable supply or disposal lines to transport water, oil, compressed air, and natural gas.

The Johnson-Fagg hydraulic subsurface pump consists of a single-acting production plunger coupled to an engine piston by a hollow connecting rod. Power fluid is pumped down the well to operate the engine piston which, in turn, powers the production plunger.

J. T. Pitts named sales manager

. . . of Brown Instruments Division of Minneapolis-Honeywell Regulator Co. He succeeds J. A. Robinson who joined the company's six-division Industrial Products Group.

J. T. Pitts

Joining Honeywell in 1945, Pitts held sales posts in Charlotte and Durham, N. C., before going to Houston where he was branch manager from 1952 to 1958. Robinson has been with the company since 1929. In his new assignment he will work closely with Honeywell's Special Systems Division in the development of computer control systems.

Hugh J. McNelis assumes post

. . . as sales engineer in the Philadelphia office of De Laval Separator Co.'s Industrial Division. Before joining De Laval, he was with Simplex Valve & Meter Co.

Oil Well Supply Division makes

. . . two appointments in its Central-Midwest area and names a new Canadian store manager. Billy E. Wright takes over as field representative at Andrews, Tex., and Robert J. Shoffstall becomes assistant district engineer—machinery equipment sales and service at Midland, Tex. Angus F. Blunderfield has been appointed store manager at Estevan, Sask.

B. L. Sharp assumes duties

. . . as sales representative for pipeline coatings and related products of Pittsburgh Chemical Co. With headquarters in Tulsa, he will serve Montana, Wyoming, North and South Dakota, Nebraska, Colorado, Kansas, Arkansas, and Oklahoma.

STILL IN TROUBLE
over process control
chromatography?

Stop brewing and stewing over the slow response in your process control systems.

CEC's new 26-212 High-Speed Process Chromatograph—the only multiple-stream, high-speed instrument of its kind anywhere—is 10 to 40 times faster than ordinary units.

The 26-212 accommodates all types and sizes of columns, multiple columns and a variety of detectors. This advanced instrument closes the loop for automatic process control ...gives you a choice of pneumatic, mechanical, electronic or computer control of rapidly changing petroleum, petrochemical, chemical and pharmaceutical processes.

For more information, write for Bulletin CEC 1860-X1 or call your nearest CEC sales and service office.

Analytical & Control Division
CEC
CONSOLIDATED ELECTRODYNAMICS
pasadena, california
a subsidiary of Bell & Howell

2 great newcomers by Pacific that welcome tough assignments ...

1

New BTV VALVES with *Dual* seating design for absolute shut-offs.

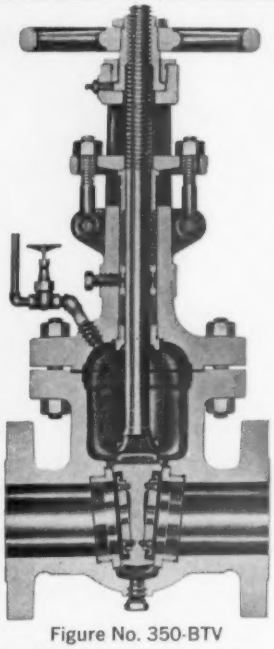


Figure No. 350-BTV

PACIFIC's Block & Bleed Gate Valves seal tightly on **BOTH** sides of the wedge. Positive visual proof of seat tightness is possible by first draining the body cavity and then connecting to the bonnet tap a pressure gage, manometer or a simple drain into a glass graduate. The primary seal in the wedge is Viton-A or PACIFIC's "Resist-Seal"; secondary seal is metal to metal for fire safe protection. Available in 150 Lb. and 300 Lb. Series.

Let PACIFIC show you how these valves better serve you . . . Write for Pacific's Block & Bleed Bulletin BV-2.

2

New BALL VALVES with *Exclusive* adjustable compression ring sealing

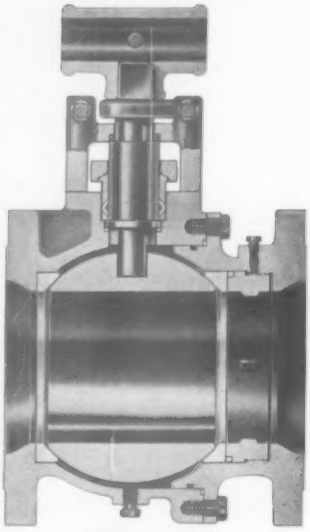


Figure No. 400

PACIFIC's NEW line of Ball Valves are available in the following sizes:

Screwed Ends . . . . . ¼" to 2"

Flanged Ends . . . . . 2½" to 14"

Standard materials: Cast Iron, Ductile Iron, Aluminum, Bronze, Carbon Steel CF8, CF8M, Alloy 20 and Monel.

Standard seal materials: Buna-N, Neoprene, Viton A, Teflon, Kel-F and Nylon. Special seal materials: Silicone rubber, Rulon and Fluorogreen.

Check the many exclusive features offered, to be found in PACIFIC's line of Ball Valves. Write for Bulletin BV-60.

PACIFIC VALVES, INC.

3201 WALNUT AVE. LONG BEACH, CALIF.

Sales Offices in Most Principal Cities with Complete Valve Reconditioning Facilities in Houston, Texas; Woodbury, New Jersey; and Chicago, Illinois.

Sharp was formerly a salesman for Standard Pipeprotection, Inc., St. Louis.

E. Theodore Beck is promoted

. . . to sales manager for Votator continuous-processing equipment of Girdler Process Equipment Division, Chemetron Corp., Louisville. Sales manager for overseas operations since 1958, he succeeds Lamar D. Roy, Jr.

Beck has been with the company since 1948, specializing in sales and engineering of continuous-processing equipment. He was eastern district sales manager for Votator equipment from 1950 to 1957.

Continental-Emsco Co. sets up

. . . a new group within the company to be known as the marketing group — machinery and miscellaneous merchandise. It will comprise the sales and merchandising divisions, and will report directly to the executive vice president of distribution.

R. O. Hambric

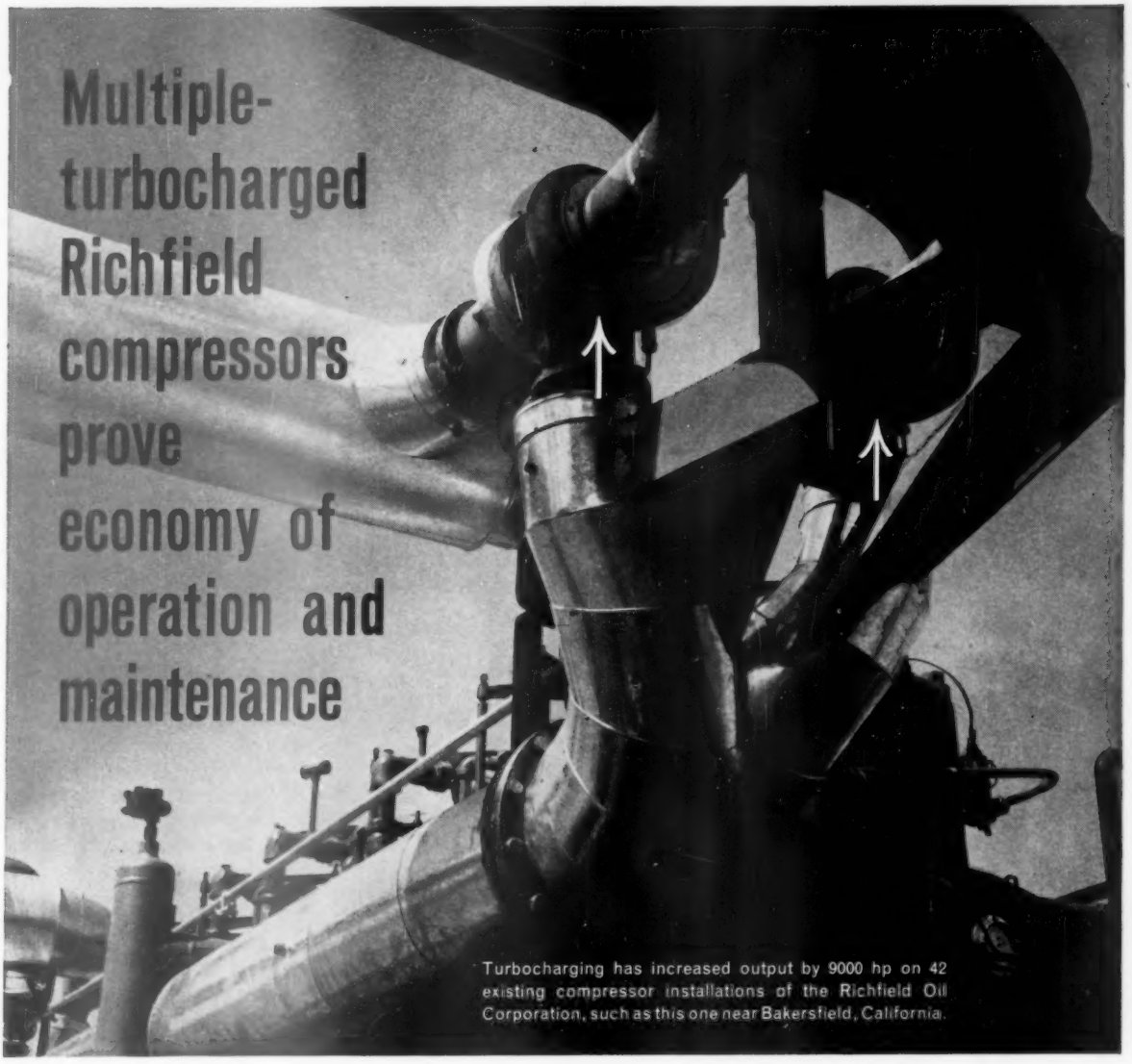
Heading the group is Roscoe O. Hambric, marketing manager of machinery and miscellaneous merchandise. Formerly general merchandise manager, he joined C-E in 1946. Robert M. Erskine, former assistant manager of sales, nontubular, is now sales manager of the group. He began with the firm in 1953 as a sales engineer. Harry Hobbs, Jr. has been named merchandising manager—machinery and miscellaneous merchandise. Formerly assistant general merchandise manager, he joined the company as a field salesman in 1953.

R. M. Erskine

Harry Hobbs, Jr.

Hardy-Griffin opens sales office

. . . in the Fidelity Union Life Building in Dallas, where David J. Gent will have headquarters. Previously



Turbocharging has increased output by 9000 hp on 42 existing compressor installations of the Richfield Oil Corporation, such as this one near Bakersfield, California.

Power output of Richfield Oil Corporation's 2 cycle natural gas compressors has been economically increased 30-40 per cent by the AiResearch multiple turbocharger system . . . utilizing existing compressors, personnel and plant size.

At the same time, during the three years in which turbocharged units have been in operation, unscheduled down time and maintenance have been at a minimum.

In addition to long service life, the turbochargers in the AiResearch multiple system are smaller, easier to handle and less expensive to maintain or replace than a large turbocharger of a single unit system.

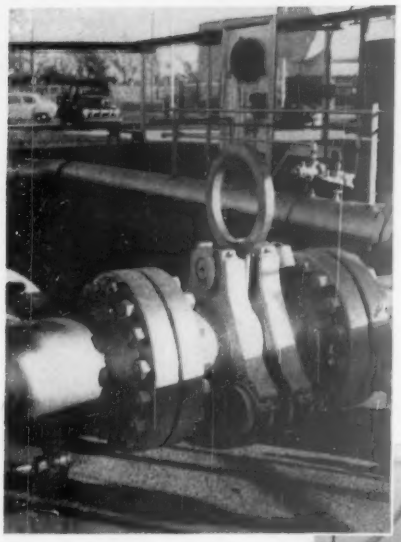
These rugged turbochargers have also accumulated many years of proven trouble-free operation in a wide variety of the most demanding vehicular applications. Extremely simple in design and requiring no separate cooling system, they are another example of AiResearch leadership in the development and production of air-cooled turbochargers and turbocharger controls for all major engine applications.

Your inquiries are invited.

THE GARRETT CORPORATION

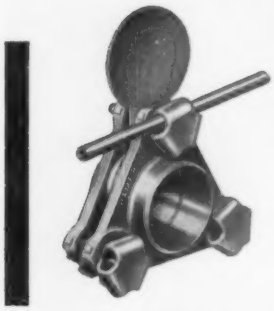
AiResearch Industrial Division

9225 South Aviation Blvd., Los Angeles 45, California



FAST, EASY, POSITIVE
LINE BLINDING

Hamer
Line Blind Valves



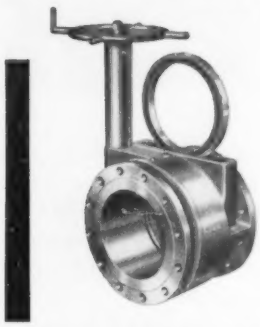
The famous 3-Bolt Hamer Line Blind Valve has set the standard for positive, dependable, economical line blinding in all industries.

FAST . . . because one man can reverse the spectacle plate from open to closed position in a matter of minutes.

EASY . . . because bar or handwheel operation provides tremendous leverage for spreading and tightening the hubs that hold the spectacle plate. Wedges, hammers, wrenches needed for spreading conventional flanges are eliminated.

POSITIVE . . . because nothing seals as securely and permanently as the solid spectacle plate clamped between the hubs of a Hamer Line Blind Valve.

Ask your nearest Hamer Line Blind Valve specialist about the multiple advantages of installing them wherever positive line shut-off is essential. Write for new Hamer Valve Catalog 60.



Handwheel operated Hamer Rigid Type Line Blind Valves are ideal for installation where conditions prevent spreading the line to reverse the spectacle plate.

WECO
WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS
Division of CHIKSAN COMPANY a subsidiary of FOOD MACHINERY AND CHEMICAL CORPORATION
HV-2-60
fmc

WECO UNIONS

CHIKSAN SWIVEL JOINTS

HAMER LINE BLIND VALVES

HAMER PLUG VALVES

Gent was production manager for Conners Steel Division of H. K. Porter Co., Birmingham. Prior to that he was with Jones & Laughlin Steel Co. and for 7 years was engaged in tubular-good sales in the Southwest, locating in Houston and Dallas.

Thomas Tefertiller becomes

. . . Oklahoma district manager of Chicago Pneumatic Tool Co.'s Oil Tool Division. He will locate in Oklahoma City. A 10-year veteran of the oil-tool industry, Tefertiller joined Chicago Pneumatic in 1955 and was appointed district manager of the Houston area in 1958. He was named assistant manager of the Oklahoma district last year.

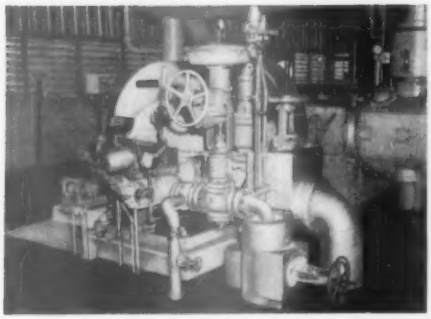
M. G. McCool resigns as prexy

. . . of American Iron & Machine Works Co., Inc., following 26 years of service with the company. He resigned a year ago, but agreed to stay on until the present. McCool is also president of Little Giant Corp. and M-C-M Machine Works. He's a director and executive committee member of Liberty National Bank & Trust Co.

McCool states his reason for resigning is to allow more time for management of his two companies and other investments. He will retain his stock ownership in American Machine & Foundry Co., parent company of American Iron, and will also remain on American Iron's board of directors. He will stay with American Machine & Foundry in an advisory capacity.

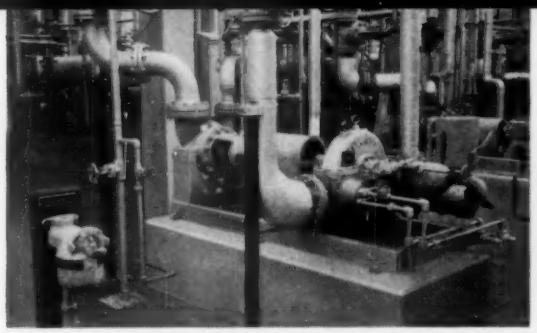
J. L. Pearce is sales engineer

. . . for Otis Pressure Control, Inc., the Canadian division of Otis Engineering Corp., of Dallas. He will headquarter in the Calgary office. Formerly in Otis' Victoria, Tex. office, Pearce served as a gas-lift engineer. He will continue in this capacity, in addition to other sales responsibilities, in his new Canadian assignment.

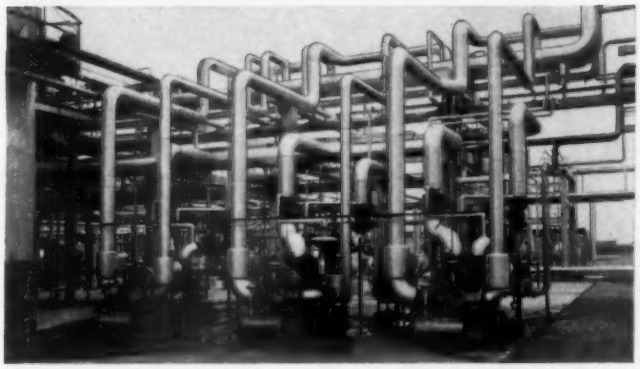


600-hp Elliott turbine driving a compressor which supplies compressed air for process.

(Right) Elliott steam turbines power many reflux pumps throughout the refinery. Shown here are three, driving gasoline column bottoms pumps in the crude unit.

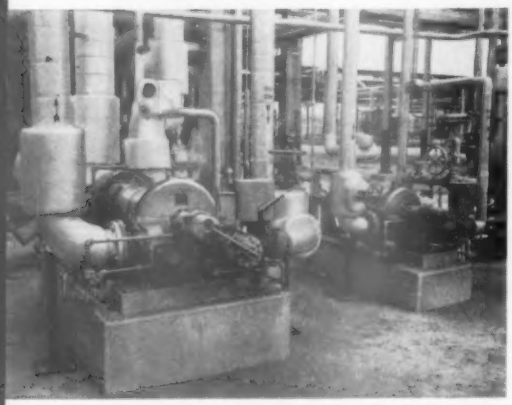


The YR turbine shown above drives an oil pump in the alkylation plant.

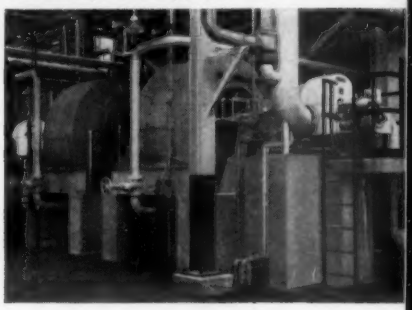


The turbine-driven condensate pump shown below charges foul condensate to stripper column.

Below are forced-draft fans driven by Elliott turbine-gear units in one of the refinery's boiler plants.



The unit on the left above is a condensate pump, and the one on the right is a seal oil and flushing oil pump. Both are driven by Elliott turbines.



FROM TURBINE HEADQUARTERS

In one refinery, 85 Elliott turbines driving pumps, compressors, fans prove Elliott versatility

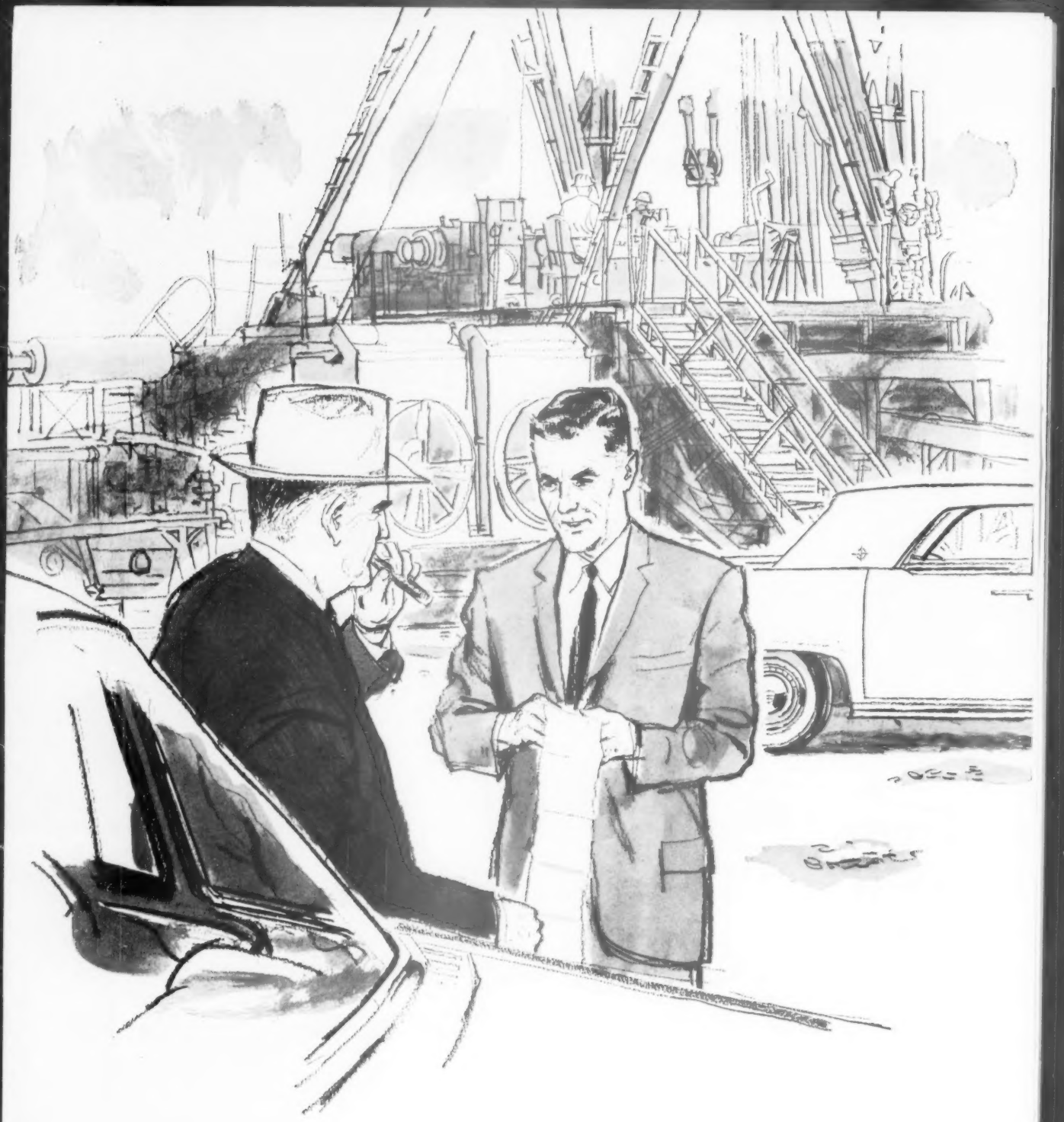
Ranging in size from 5 to 935 horsepower, these Elliott YR single stage turbines are installed in a giant East Coast Refinery. The units were selected from a modern, field-proven line of mechanical drive turbines rated up to 50,000 horsepower.

Installations like this together with experience of more than 50 years in turbine design, manufacture and application are among the reasons why Elliott is truly "Turbine Headquarters." Write for descriptive bulletin H22-D. H1-2

ELLIOTT COMPANY

GENERAL OFFICES: JEANNETTE, PENNSYLVANIA PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio

TURBINES · GENERATORS · MOTORS · COMPRESSORS · TURBOCHARGERS · EJECTORS · STRAINERS · TUBE CLEANERS



"Every officer in their Oil & Gas Department was an oilman before he became a banker. That's the reason we moved our account to Bank of the Southwest. They are really on our team."

Bank of the Southwest
NATIONAL ASSOCIATION, HOUSTON
Member F. D. I. C.

Safety awards given

THE ANNUAL safety dinner of Miller & York, Inc., and General Production Service, Inc., of Bakersfield, Calif., honored employes with awards. F. A. York, (left), an officer of the firms, is shown with the recipients.

Awardees are: (back row from left) Ernie Harris, S. R. Collins, Haskell Howard, M. F. Youngman, and Edgar Chancellor. In the front row (from left) are: Ray Haralson, William J. Brossard, Harold Henderson, Ledo J. Agostinelli, and A. T. Winslow. These drillers received savings bonds from their companies in addition to AAODC certificates. Winslow and Harris are with General Service, while the rest of the men are employes of Miller & York.

Crew men of Miller & York who received AAODC cards and billfolds from the firm were: A. O. Burgess, E. J. Cockren, E. L. Denison, M. J. Frank, Manuel Garcia, Cleveland Henderson, Joe Henderson, Paul Hodge, Billy Hyatt, W. J. Kuykendall, B. L. McKinney, J. A. Mulkey, J. T. Sons, K. W. Wallace, Leroy K. Works, and C. F. Young.

Crew men of General Service who received cards and billfolds were: Floyd Hamilton, Harry Hood, Denton McGuire, Travis Marchant, E. C. Smith, James E. Thomas, Ralph Thurman, and W. H. Norman.

William F. Patton, another officer of the firm, concurred with York in remarks made during the presentations that since the safety program was inaugurated in 1954 the number of injuries and lost time has been substantially reduced.

More data on Kingfisher County

Due to space limitations, the following data were not included in the writeup on Kingfisher County in the Journal issue of March 27, page 149:

22. Pressures: Tubing, 100 to 2,800 psi.; Casing, 450 to 2,280 psi.

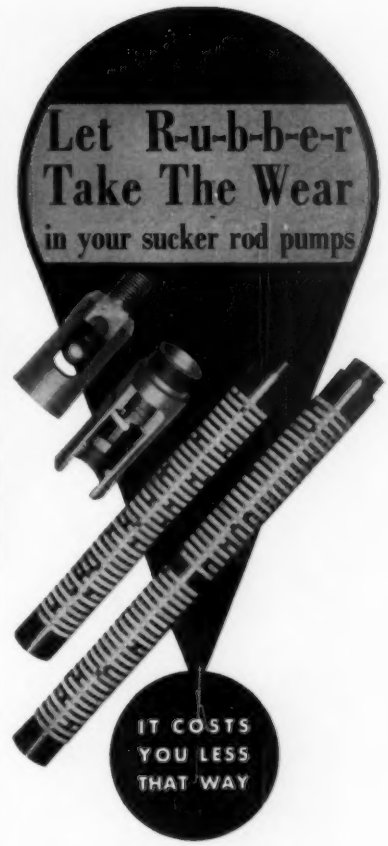
23. Tests and logging procedures: Drill-stem tests, cores, and electric logs are run in most holes.

24. Pipeline outlets: Champlin Oil & Refining Co. (Cimarron Valley Pipeline Co.) is the leading crude purchaser. Continental Oil Co. is building a line to serve part of the area.

25. Exploration methods before discovery: Seismic, subsurface geology, and random drilling.

26. Average costs: Dry hole, $62,000. Flowing well, $107,000. Average total depth, 8,200 ft. Footage price, $5. Day rate with pipe, $825; without pipe, $750. Average lease price in 1956 was $5 per acre. In 1959 cost had risen to $25 to $40 per acre. Price depends largely on immediate sector.

27. Crude analysis: (Manning) Gravity, 39.7° API. Sulfur, 0.13%.



MARTIN RUBBER & DUCK RINGS give excellent life in dirty abrasive fluids . . . high or low gravity . . . much or little water . . . shallow or deep wells. They last for years in the easier pumping wells. Replacement rings cost comparatively little.

MARTIN PLUNGER BODIES, precision grooved, drilled and threaded (no underneath fluid passage), usually last for years. Tube or barrel costs are often cut in half.

The replaceable SYNTHETIC RUBBER GUIDES in MARTIN CAGES last longer than any metal, and the cushioning of the ball increases your ball & seat life. Results are often truly amazing. (Patent No. 2,591,174)

Write for our new catalog or see it in the Composite (24th Edition). All products sold thru supply companies.

JOHN N. MARTIN
Manufacturer
9 W. BRADY STREET • TULSA, OKLAHOMA

NOW WITH

POLARIZED

ADDITIVE

Greater "Clinging" Power for Increased Thread Protection!

Jimmie Gray®

"500 TON"

Used on more wells throughout world-wide drilling industry!

SOLD ONLY THROUGH SUPPLY STORES

MONEY BACK GUARANTEE

USE JIMMY GRAY DOPE BRUSHES

PETROLEUM DISTRIBUTING CO.

BOX 703—HOUSTON, TEXAS—CApitol 4-9648

28. Yield data: (Manning).

Product	%	Vap. temp., °F.	Gravity
Gasoline	8.6	1-212	39.3
Naptha	21.4	212-392	39.3
Kerosine	15.9	392-527	39.3
Gas oil	16.5	527-738	30.4
Lube distillate	21.2	738-985	30.4
Residue	14.9	985	19.5
Loss	1.5	...	...

H. Ed Lindsey, Jr.

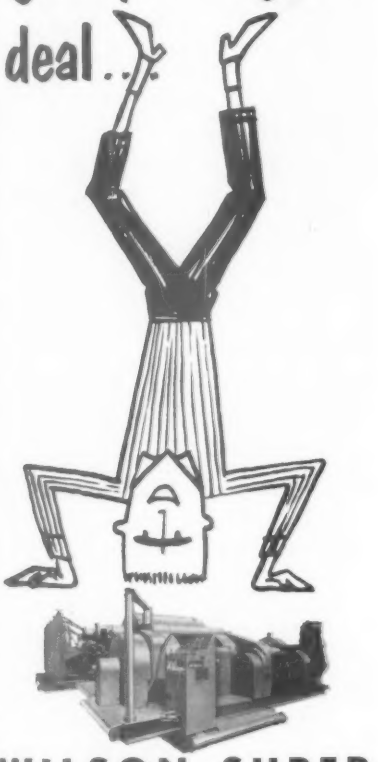
Interest acquired in Midland service firm

ACCORDING TO a joint announcement by H. Ed Lindsey, Jr., president and owner of MWL Tool & Supply Co., and Cecil B. Scott, president of Diamond Oil Well Drilling Co., MWL acquired a 50% interest in DOWDCO. Both Midland firms operate in the Permian basin.

The purchase was made from American Research and Development Co., Boston. Retaining the other 50% interest in DOWDCO is J. K. Smit and Sons, Murray Hill, N. J. The firms will continue to operate separately, and Lindsey will serve as president and manager of both. Scott will join Charvon Corp. as president of that company.

According to Lindsey, MWL, operating in conjunction with DOWDCO, will result in much more diversified operations since the services of the companies are complementary to each other. MWL handles a complete line of oil tools and services, while DOWDCO specializes in diamond bits and coring services.

We'll stand on our heads to give you a good deal...



WILSON SUPER ATLAS RIG

See us before you make any deal

- All friction clutch transmission
- Clutches outside the drum
- Full vision panel control

Wilson

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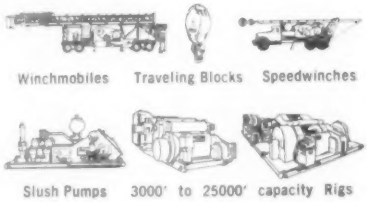
Wichita Falls, Texas • The Home of RED IRON

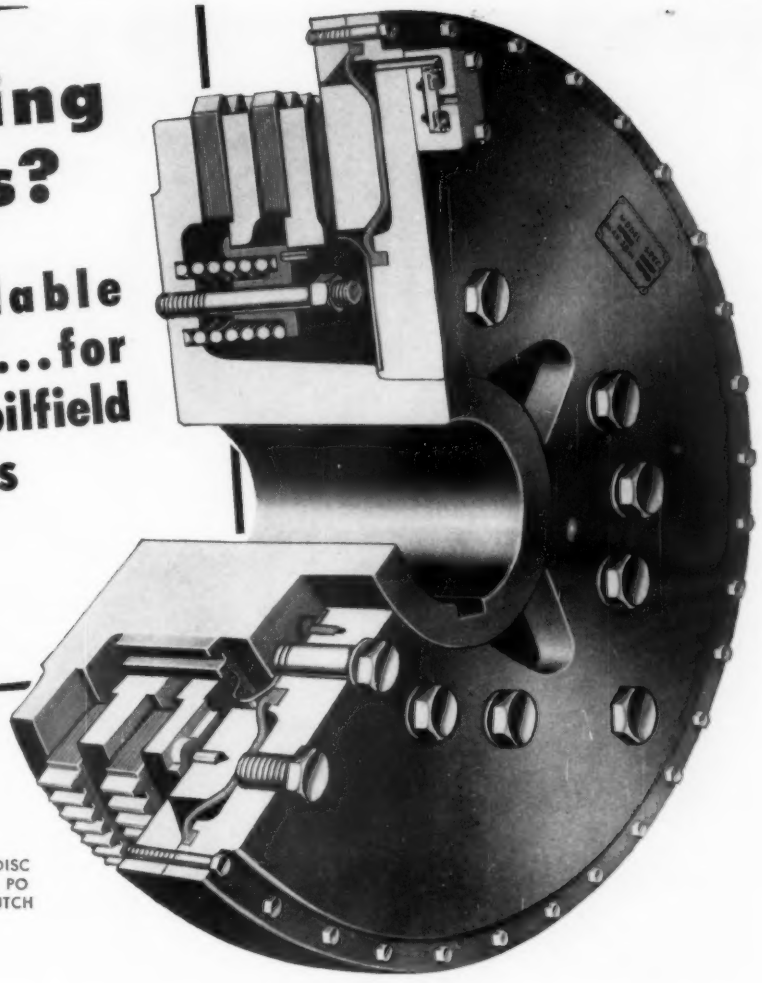


Winchmobiles Traveling Blocks Speedwinches

Slush Pumps 3000' to 25000' capacity Rigs

Modernizing your rigs?

Here's dependable remote control...for all heavy-duty oilfield applications



TWIN DISC
MODEL PO
AIR CLUTCH

A complete line of Twin Disc PO Air Clutches—from 8 to 36 inches in diameter — is available to give rig operators remote power control without complicated, troublesome linkage. These heavy-duty air clutches have long proved excellent as master clutches, rotary clutches and high and low-speed clutches on drawworks . . . as well as many, many other oilfield applications. Their compact size in relation to torque capacity makes for easy replacement of old-style, bulky band or drum clutches.

Here are just a few of the many profitable advantages gained through use of Twin Disc PO Air Clutches:

• *They are convenient.* The equipment operator can connect and disconnect power to machinery from a remote station, which lends itself to the trend toward central control for over-all drilling operations.

• *They are dependable.* New advanced design and long-lasting neoprene diaphragms eliminate leakage . . . provide excellent reliability and long life.

• *They meet virtually every power requirement.* Twin Disc PO Air Clutches are available with torque capacities up to 166,800 lb.-ft. and can handle loads up to 1640 hp.

• *They feature constant torque control without adjustment.* Twin Disc PO Air Clutches are self-compensating for wear.

• *They are inexpensive in relation to their capacity.* Smaller PO Air Clutches cost up to 40 per cent *less* than many similar clutches.

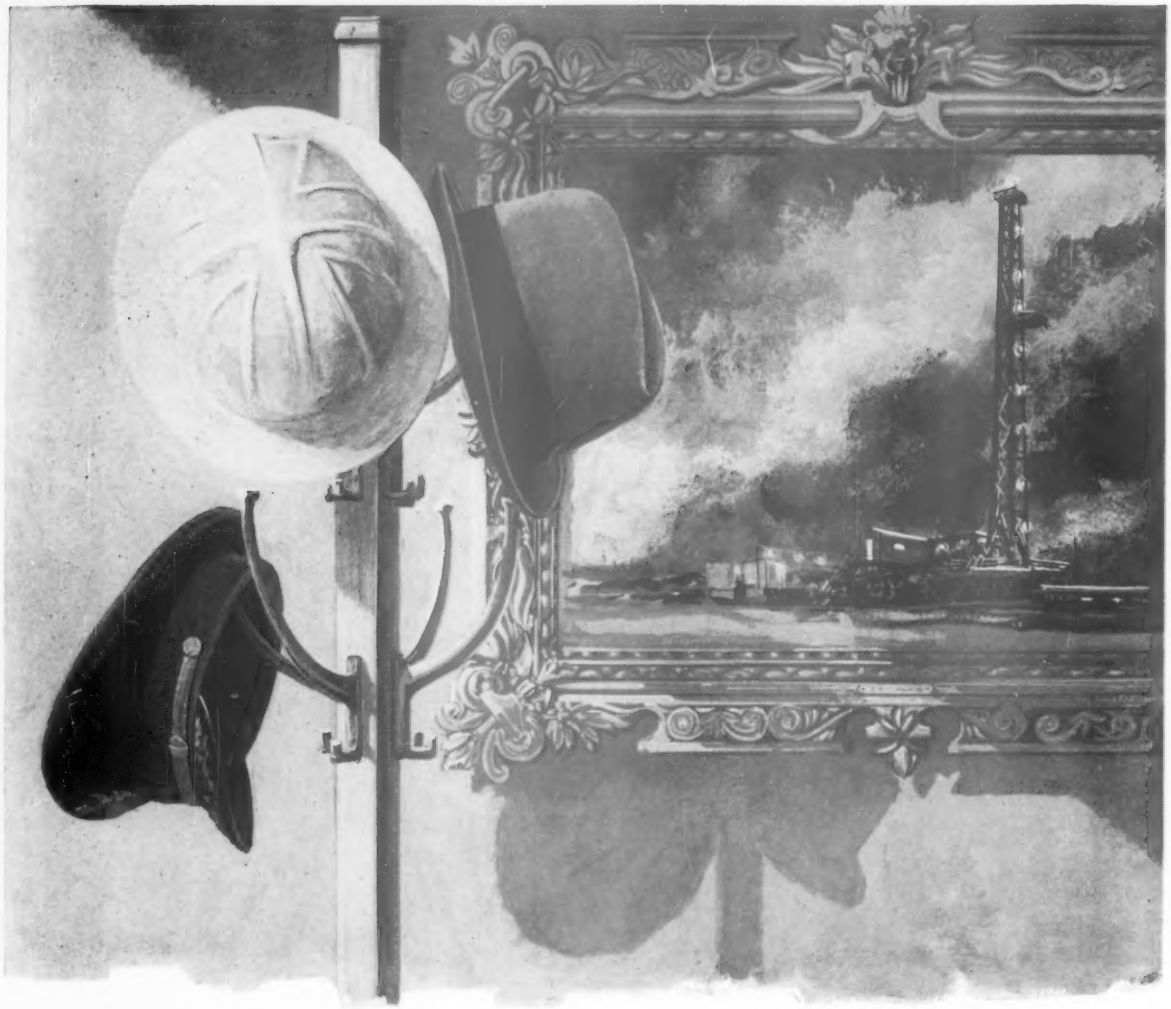
• *They are compact.* Twin Disc PO Air Clutches can increase the capacity of a rig without increasing the physical size of the clutch. Often space requirements are reduced.

If you're modernizing your rigs or other oilfield equipment, and if convenient, dependable remote control is your goal, by all means specify Twin Disc PO Air Clutches. For complete details, write Twin Disc Clutch Company, Racine, Wisconsin.

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC

Friction Clutches and Fluid Drives



RHIA [RANK HAS ITS ADVANTAGES]

For decades, oil and gas men have turned to the Republic for the many varied and special bank services they require. Republic knows you must have accurate fact and figure data, prompt decisions on financing, and frequently, bank counselling with your lawyer on regulations and tax matters.

As a pioneer oil bank in the South . . . with the South's largest Oil and Gas Department, Republic is uniquely equipped by experience, knowledge and resources to give you the complete, specialized service you need.

Doing business with Republic Bank indeed has its advantages and they are in your favor. Next time, talk to Republic, indisputably a leader in the field of oil and gas financing. We're here to serve you.

REPUBLIC NATIONAL BANK
OF DALLAS

"My Bank to the Oil and Gas Man

MEMBER, F.D.I.C.

CAPITAL AND SURPLUS $105,000,000 ★ LARGEST IN THE SOUTH

MIDDLE DEVONIAN-SLAVE POINT gas production was pushed far to the north into the Northwest Territories last week, as Imperial Oil Ltd. ran production tests at its new discovery, the F-7 Netla, in the Arrowhead River region.

Arrowhead River strike expands Canadian gas arena

BY FRANK J. GARDNER

NORTHWESTERN CANADA'S Slave Point-Devonian rocks yielded yet another interesting discovery last week. This formation, which has paid off so handsomely in northeastern British Columbia and western Alberta, is a relative newcomer to Canadian reservoir columns; its first production was recorded at Virginia Hills field, Alberta, in February 1957, but since then it has become a prime target in northwestern exploration.

The new discovery lies in the Northwest Territories and is a long north stepout to the Northeast B. C. gas play. It's the fourth discovery for the Territories, and the second in this immediate region.

A push to the north . . . Imperial Oil Ltd. drilled the new strike as D-7 Netla, and now has redesignated it the F-7. Location is Lat. 60° 46' 15.04" N., Long. 122° 46' 15.02" W. on Permit 1038. It lies on a 437,974-acre spread farmed out by Sun Oil Co., 45 miles northeast of Fort Liard, and 136 miles north of Fort Nelson, B. C. It is generally called the Arrowhead River region.

On production tests at the well, recorded gas flow was 6,800 M.c.f. per day from a 48-ft. interval at 6,394-6,442 ft. Middle Devonian was topped at 6,340 ft. (4,321 ft. subsea), and the well was carried to total depth 7,771 ft. Further testing is scheduled to determine the well's true worth.

Imperial has already staked the second well in this area. It's the 1-46 Arrowhead, to be drilled 12 miles east of the F-7 Netla at Lat. 60° 45' 37.15" N., Long. 122° 22' 46.96" W., on Permit 1040.

This is the first discovery in the Northwest Territories since Home Oil Co., Ltd., et al. finished its 2 Celibeta Lake well last April. That strike, about 45 miles southeast of the new Netla well, made 6,000 M.c.f. per day from Slave Point at 3,745-65 ft., a much shallower depth than either the Netla or the fields of Northeast B. C. Home had only the one success out of four attempts at Celibeta.

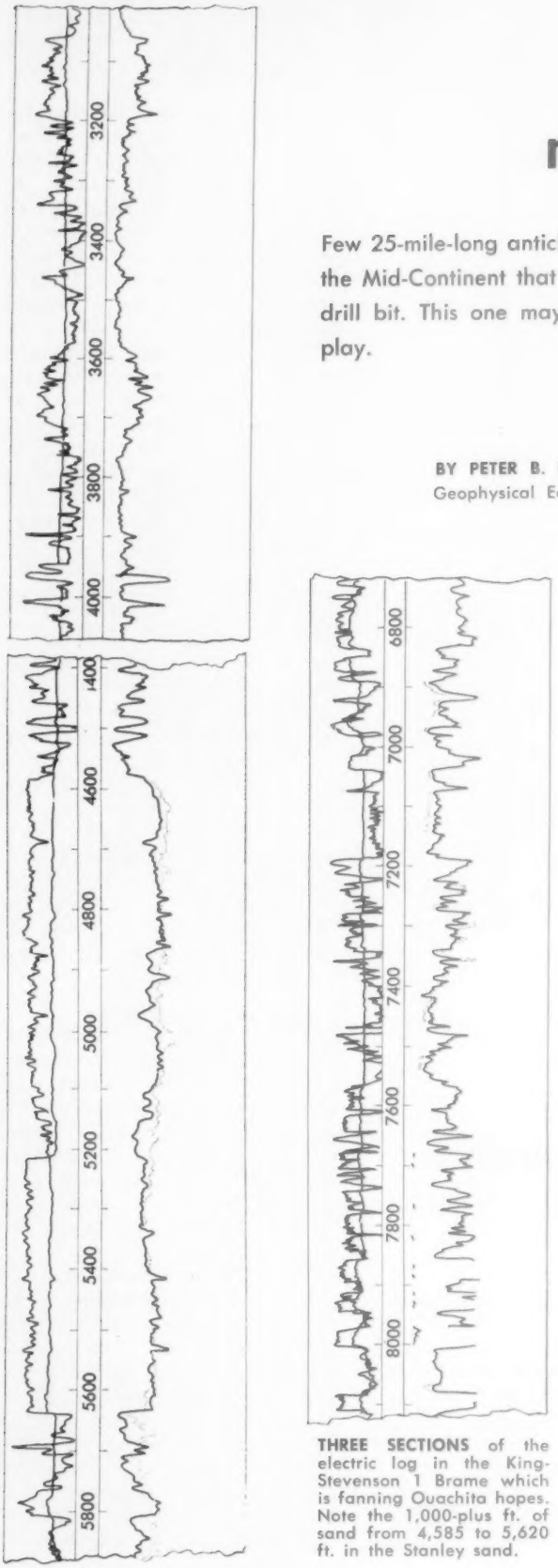
For future reserves . . . Once again, the great potential of Canada's northern lands is demonstrated. And once again the vastness of the job ahead is emphasized. But to stimulate the search, an outlet for these northern fields must materialize, and that possibility is remote at the moment, following the disappointments of Celibeta.

Westcoast Transmission Co., Ltd., is eying all these areas as future sources of gas; early last fall it was thought that a gas-gathering system might be completed as far north as Celibeta by 1962. Now, the line may be delayed, for the buildup in new reserves during the past winter season fell below expectations. But when it does come, the blueprints may call for lines 45 miles farther north than before.

Watchful waiting in may end–pending outcome of

Few 25-mile-long anticlines remain in the Mid-Continent that haven't felt a drill bit. This one may open a new play.

BY PETER B. BIKE
Geophysical Editor



THREE SECTIONS of the electric log in the King-Stevenson 1 Brame which is fanning Ouachita hopes. Note the 1,000-plus ft. of sand from 4,585 to 5,620 ft. in the Stanley sand.

WHAT MAY PROVE TO BE one of the most important tests in the state is quietly drilling in Pushmataha County, Oklahoma. The venture is Apache Oil Corp. 1 Dumm located C NE NE 22-2s-16e, drilling below 8-in. surface casing set at 1,300 ft.

What's so significant about this operation? Actually, this test will help determine whether an unusually thick section of Stanley-Mississippian sand is present on the prominent Moyers anticline. This pronounced feature has a surface expression which is believed to diminish with depth. Approximately 25 miles in length, Moyers anticline is a well-known structure of southeastern Oklahoma.

A year ago there was no production in Pushmataha County. Last summer, King-Stevenson Oil Co. drilled its 1 Brame well, C NW SE 15-3s-15e, to a depth of 8,371 ft. Several gas flows were encountered varying from 20-500 M.c.f. One section in the Stanley logged more than 1,000 ft. of sand. Although the gaged flows were not too large, recent reports indicated that flow was increasing. Unconfirmed reports state that the unreleased sonic log indicated porosity of 14 to 15% in the Stanley section, of which only 240 ft. of the more than 1,000 ft. of sand was tested in open hole.

It has just been announced that Harvest Queen Mill & Elevator Co., represented by C. A. Caswell of Oklahoma City, will drill a 6,000-ft. test offsetting a pair of dry holes on the Jumbo anticline. Operation is the Harvest Queen 1 Brame in NE NW NE 16-2s-15e. The two abandoned ventures are Southwestern Exploration 1 Denton Perrin which was drilled in 9-2s-15e and the Caulkins Oil Co. and Sikes-Burkhalter Drilling Co., et al. 1 Perrin just east of the Southwestern dry hole in the same section.

A huge untested province. The Ouachita Mountains geologic prov-

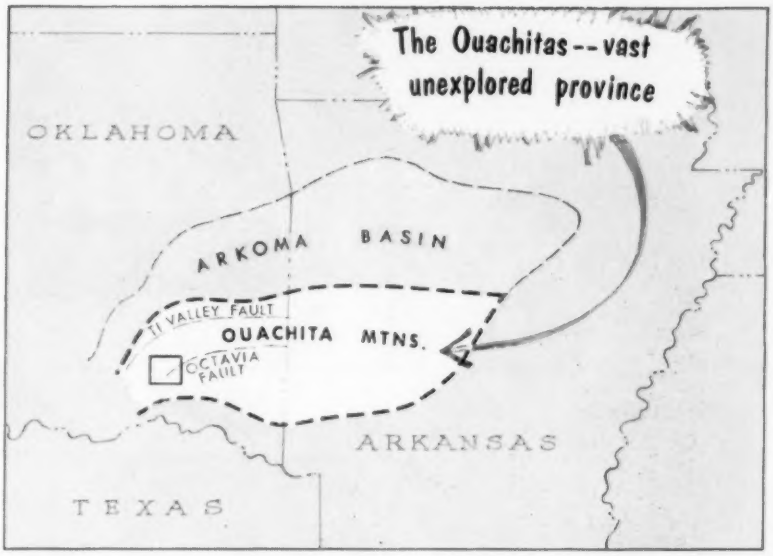
Ouachitas

key test

ince encompasses a large portion of Southeast Oklahoma and West-Central Arkansas. Many explorationists have long considered the region a "never-never land" for commercial petroleum reserves. Only recently, has interest picked up to the point that people were willing to test it with the drill. There are several reasons why the area has gone unchallenged so long, but probably the most dominant ones are its complex geology, the fact that the carbon-ratio theorists don't give it much promise, and that it is considered predominantly a gas area if any hydrocarbons exist.

Pushmataha County is a large area in itself. With over 1,420 sq. miles, there have been only three tests drilled so far this year. Besides Apache, Sinclair Oil & Gas Co. 1 Herrick, NW NE SW 11-2n-20e, is drilling below surface casing set at 801 ft. with a proposed depth of 3,000 ft. Shell Oil Co. 1 Dierks, was recently abandoned as dry at a total depth of 5,001 ft. Since January 1, 1955, only seven wells have been drilled in the county for a footage total of 34,909 ft. This is a per well average of 4,987 ft. Yet only four tests have been drilled below 3,000 ft. in the Stanley section. With 39½ townships (1,422 sections) in the county, it is easy to see how sparsely tested the area is.

The Ouachita Mountain province is a vast area and the Oklahoma portion consists of several thousand square miles. Parts of it can get pretty rugged, as evidenced by the presence of the Kiamichi Mountains to the east. In the locale of the Apache wildcat, the Kiamichi River flows southwest through a fairly flat river valley about a mile east of the drill site.



JUXTAPOSITION of the Ouachita Mountains to the Arkoma basin is likely to result in two tremendous gas areas of the Mid-Continent area. Both are Johnny-come-latelys on the exploration scene. The boxed area in the southeastern part of the Ouachitas is the locale discussed.

A dominant structure. The Moyers anticline is no stranger to the literature. The Oklahoma Geological Survey surface map prominently displays the feature as a northeast-southwest trending structure. Its surface expression reflects dips on the flanks up to 55°. At depths of 5,000 ft., the dips are believed to be in the range of 25° with closure of about 1,500 ft. The more steeply dipping surface beds are considered to be the result of compressional effects near the surface. The Dallas and Ardmore geological societies presented a detailed map of the Moyers anticline in their joint Ouachita guidebook published in April 1959.

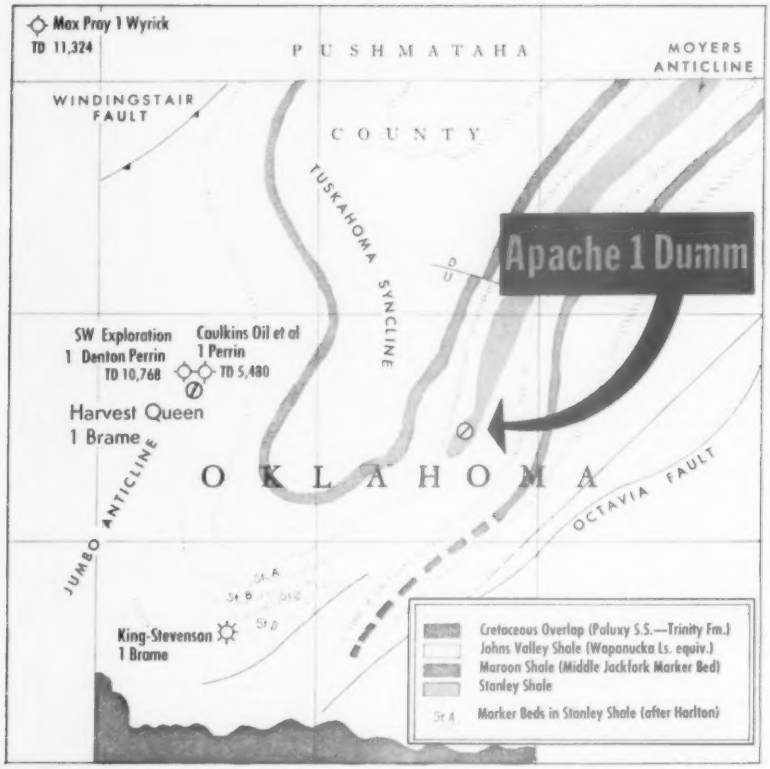
Of particular interest to Apache is the Kasoma portion of the feature. This local part of the over-all Moyers structure shows closure in all directions and has a surface expression of about 15 miles.

The King-Stevenson well uncovered over 1,000 ft. of sand in one section of the Stanley. Several shows of gas were found in the well and no water was encountered below 3,000 ft. Yet the location of the well is believed to be on a separate anomaly of the Moyers structure. What Apache is seeking is a similar thick sand section that may not be as tight or may produce some oil along with the gas. Here's the reasoning behind the location of 1 Dumm.

Numerous gas shows in 1 Brame and other wells in the vicinity indicate that source beds are present. The logs show that reservoirs do exist due to the sand sections yielding gas and the tremendous sand thicknesses shown on the logs. All that remains to be found is an adequate trap. Structural conditions lend credence to the belief that a trap is present.

A cross-section plot of the logs shows that the Stanley sand may have a wide distribution. Surface beds are Mississippian-Stanley group and are believed to be roughly similar in character to the Pennsylvanian-Springer in southern Oklahoma. With the presence of thick Stanley sands at King-Stevenson 1 Brame well to the southwest, roughly along strike of the Moyers anticline, it is hypothesized that the Llanoria land mass lies to the east and south of the Apache test. Considering this, a similar thick parallel depositional pattern may be present along with a suitable trap at the drill site, with onlapping and thinning occurring somewhere to the east.

Proposed drilling program. Histories of wells drilled in the area have produced a custom-drilling plan. The literature states that the Stanley to the south and west contains volcanic tuffs and the sands have bentonite in them. Natural bentonite is not very compatible with drilling fluids and may cause swelling problems. It is likely that water invasion in the King-Stevenson well may have caused bentonite



WHETHER the King-Stevenson 1 Brame will prove commercial remains unknown. Two other tests will probe separate features. Moyers anticline will undergo exploratory investigation by the key test—Apache 1 Dumm. To the west, Harvest Moon 1 Brame on the Jumbo anticline may reap a rewarding yield.

swelling and adversely affected the pay formations, resulting in lower yields than normally would be recovered.

The drilling of the Southwestern Exploration 1 Denton Perrin located in 9-2s-15e, began with air drilling and exceptionally fast penetration was achieved to a depth of 1,000 ft. There, water was encountered causing swelling shales. A 400-viscosity mud was used in much of the drilling from this point and penetration was very slow.

Here's what Apache planned for a drilling program: Drill with air until water is encountered (anticipated from 900 to 1,200 ft.). Case off the aquifiers with a protective pipe. Continue drilling with air to a proposed depth of 6,000 ft. or the Arkansas novaculite, whichever comes first. But just below 1,300 ft., another water zone was found, forcing the operation to go to mud drilling.

Independents are prominent in the region. King-Stevenson started the ball rolling in this little-explored geological province when it uncovered a flow of 500 M.c.f. in perforated intervals from 3,062-3,710 ft. in the Stanley sand for the first gas volume approaching commercial amounts in Pushmataha County. Now comes another independent oil firm that is willing to take a calculated risk on a virtually untested area.

With numerous shows that have been found by several wells drilled in the vicinity, promise for yet more to come is encouraging. The big question is whether sufficient porosity and permeability occur on this portion of the Moyers anticline.

Another current county activity is the Sinclair 1 Herrick. All that remains to offer inducement to other operators to do more Pushmataha drilling is a successful completion at this Kasoma test. Other independents who have staked drilling claims in the county include Max Pray, Southwestern Exploration, Inc., and Caulkins Oil Co. et al., while major firms with recent drilling are Shell and Sinclair.

No midroad sentiment. There is no neutral feeling regarding the Ouachita Mountains geological province and its hydrocarbon potential. Some exploration people couldn't care less if the known features were never tested. Not only do they profess that its not their cup of tea, but they go on and emphatically state that it's foolish to even contemplate any evaluation. These appear to have gained some moral support from the carbon-ratio theorists. They consider the Ouachita area somewhat similar to the coal-bearing Arkoma basin.

Opposing this school of thought are those who think that carbon-ratio studies in the region are sadly lacking, the Ouachita facies are not coal bearing, and it's a horse of another color.

Though pessimists usually can find reasons to support their hypotheses, others in this clan decry the area by claims that source beds are lacking, the area has undergone metamorphism, or that silicification of the older beds, and thrust faulting nullify all chance for hydrocarbon reserves.

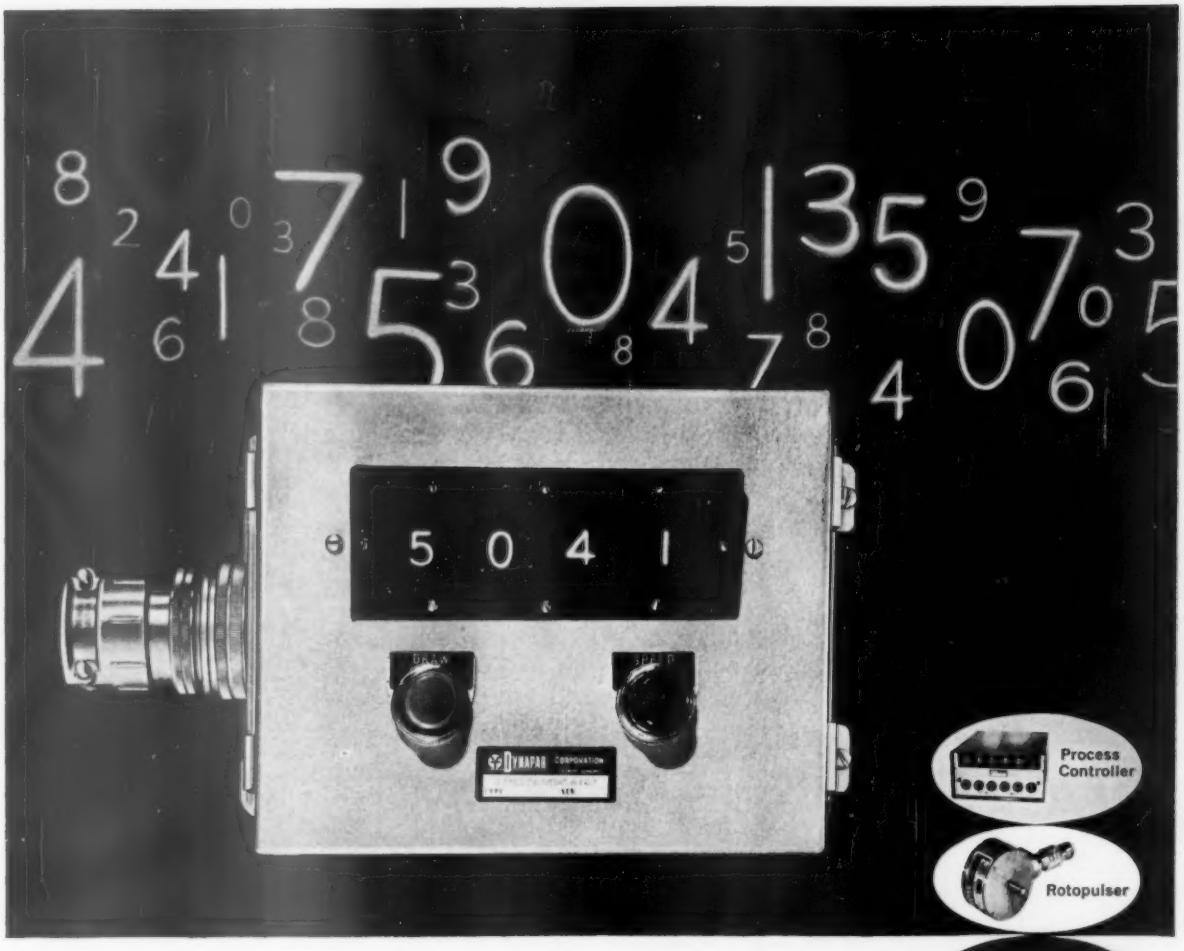
What do the optimists think? They feel that source beds are present, that encouraging shows point to unfound reserves, and that faulting—thrust or otherwise—only enhances the trap possibilities.

Look at some of the prominent features in the Rockies that were once written off after a very few tests were drilled on their surface crests. Later, the enterprising optimists found that the problem, in some cases, was purely a hydrodynamic effect and some of the features were found to have flush production on the flanks. Although this isn't the case in southeastern Oklahoma, it proves that the riddles can be solved. Wanted—more enterprising optimists in the Ouachitas!

Oklahoma gets deepest Penn oil

OKLAHOMA'S deepest Pennsylvanian producer and its second-deepest producer is Gulf Oil Corp. and Tidewater Oil Co. 1 E. L. Wood, Laverty field, Grady County.

The well, located in C W½ SE NW 29-6n-8w, flowed 5 M.M.c.f.d. through 13/64-in. choke with 34 bbl. condensate per million from perforations in the Springer at 16,180-16,376 ft. The Journal



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stated in March 20 issue that this was the deepest producer in the state since British-American Oil Producing Co. 1 Krieger in Knox field, Stephens County, was completed farther up the hole. It is producing at 16,526-46 ft. in Ordovician Oil Creek sand, and remains the state's deepest producer.

Arkoma basin field extended to the west

The west side of Northwest Kinta field in Haskell County, southeastern Oklahoma, was extended at Apache Oil Corp. 1 Smith-Carr unit, SE SW NE 16-8n-19e.

Basal Atoka Pennsylvanian sand production was found at 5,873 ft. Flow was 4,500 M.c.f.d. through ¾-in. choke.

Dual oil producer for Oklahoma's McClain

In McClain County, Oklahoma, Sunray Mid-Continent Oil Co. has finaled a dual oiler in Northeast Payne pool.

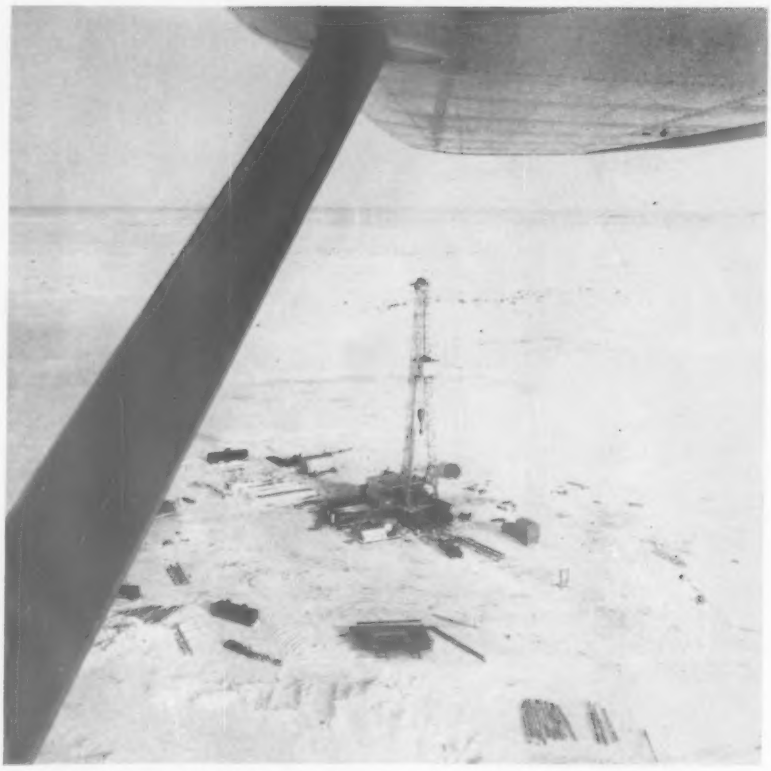
The 1 Clagg, NE SE 22-5n-3w, flowed 168 bbl. of oil a day through ¼-in. choke from Hart perforations at 7,674 - 86 ft. Tubing pressure registered 325 psi. Deeper in the hole the well flowed 480 bbl. of oil a day through ¼-in. choke from perforations in the Hunton at 7,933-59 ft. Tubing pressure was 700 psi.

Custer County wildcat hits Meramec production

A wildcat in western Oklahoma's Custer County, Mobil Oil Co. 1 Horton, C SE NW 14-15n-15w, east of North Custer City Hunton Siluro-Devonian field, flowed 1,018 M.c.f.d. from perforations in the Meramec Misisssippian at 13,192-13,215 and 13,300-60 ft. From Oswego perforations at 9,722-78 ft. the well made 173 bbl. of oil per day on ⅝-in. choke.

Blaine County. Pan American and Perkins Production Co. have two Red Fork Pennsylvanian sand producers in a Chester Mississippian field, Northwest Okeene.

Pan Am's 1 Worley, C SE NW 2-19n-11w, flowed 15,800 M.c.f.d. from perforations at 7,212-16 ft. Perkins 1 Weber in SW NE SW 14-19n-11w flowed 3,900 M.c.f.d. from 7,360-78 ft.



IN SOUTHWESTERN ALASKA Pan American Petroleum Corp. et al. 1 Napatuk Creek wildcat well in Bethel basin, was spudded in March. Photo was made during rigging up. Well is to be drilled to 10,000 ft. to test oil and gas possibilities in the Bethel basin, a large sedimentary basin extending 200 miles inland from the Bering Sea and ranging from 40 to 200 miles wide. Napatuk Creek is the first wildcat to be drilled in the area.

Far-North wildcat spuds in during below-zero weather

THE FIRST WILDCAT WELL to be drilled in the Bethel basin of southwestern Alaska was spudded March 20.

Pan American Petroleum Corp. et al. 1 Napatuk Creek is some 60 miles west of the town of Bethel.

The well is on a federal development-contract area including some 450,000 acres. It is 450 miles west of Anchorage.

Bethel basin, which lies between the Kuskokwin and Yukon rivers, ranges from 40 to 200 miles wide and stretches 200 miles inland from the Bering Sea.

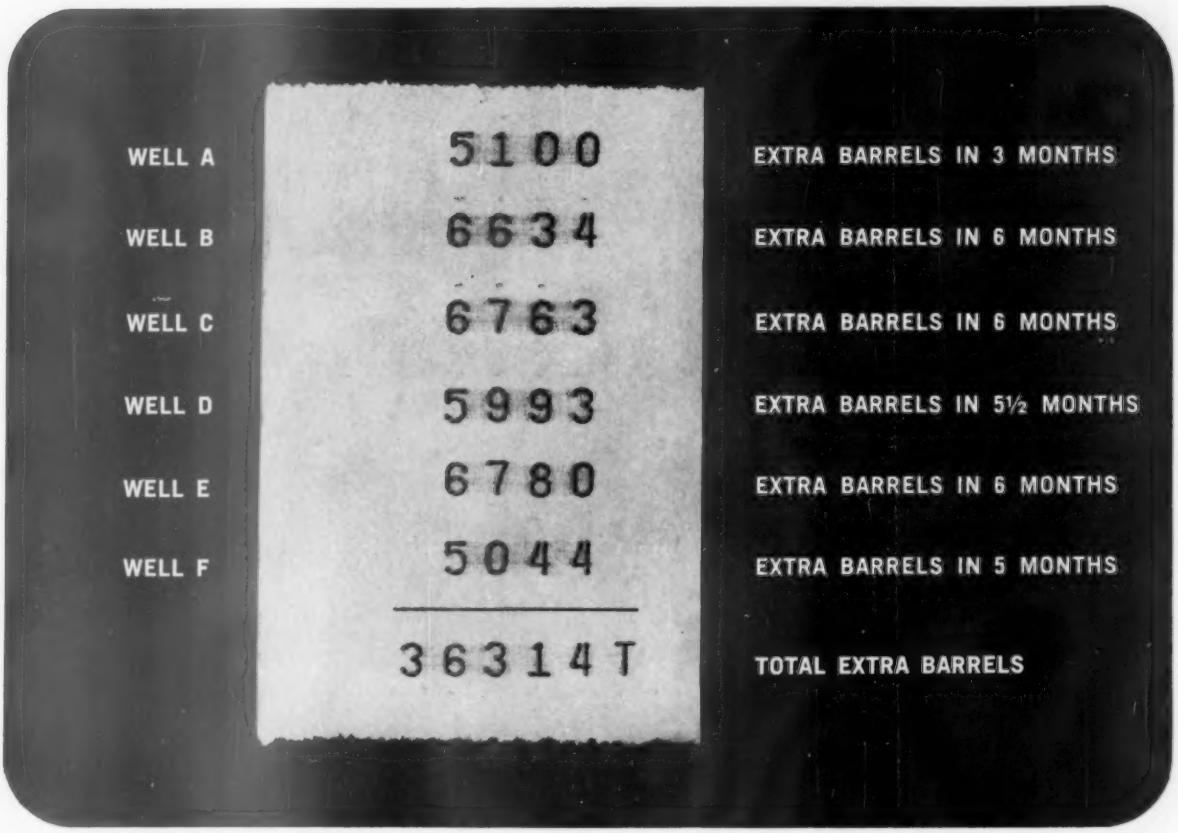
The rig and other drilling equipment has been stockpiled on the banks of the Johnson River since early last September. Equipment and supplies were moved from Seattle by ocean barge last fall to avoid hazardous navigational problems later in the year.

The mild early winter in Alaska hampered construction of the 46-mile snow trail over the tundra, as well as building of ice bridges necessary to truck the equipment to the well site. Swamp and muskeg conditions permit movement of heavy equipment only during the winter freezeup season. An aircraft landing strip has also been constructed at the site.

The wildcat is scheduled as a 10,000-ft. test, although the rig being used is capable of going below 14,000 ft.

Partners with Pan American in the venture are Sunray Mid-Continent Oil Co., Empire State Oil Co., Pacific Petroleums, Inc., Home Oil Co. of Canada, Bristol Bay Oil Co., Baysel Oil and Gas Co., Southland Royalty Co., Devon-Palmer Oils, Inc., Carolina Oil Co., and Madison Oils, Inc.

could you use production increases like these?



This operator got 36,314 barrels of extra oil from six wells within six months after they were fractured by Dowell. Total service costs for the six treatments averaged only $2931.79 per well. The extra oil produced during the first six months, as a result of fracturing, cost less than 49 cents per barrel. Additional production after the first six months will be almost clear profit.

All six wells, in Manitoba, Canada, were treated by Dowell at about the same time. All were given similar treatments in which 50,000 pounds of 20-40 mesh sand, at 2-3 pounds per gallon of lease oil, were injected into the pay zone at about 40 bpm. The production gain was determined for each well by comparing total production for equal periods immediately before and after treatment. Production periods were six months for three of the wells. Records for the other three wells covered 5½, 5 and 3 months, both before and after treatment.

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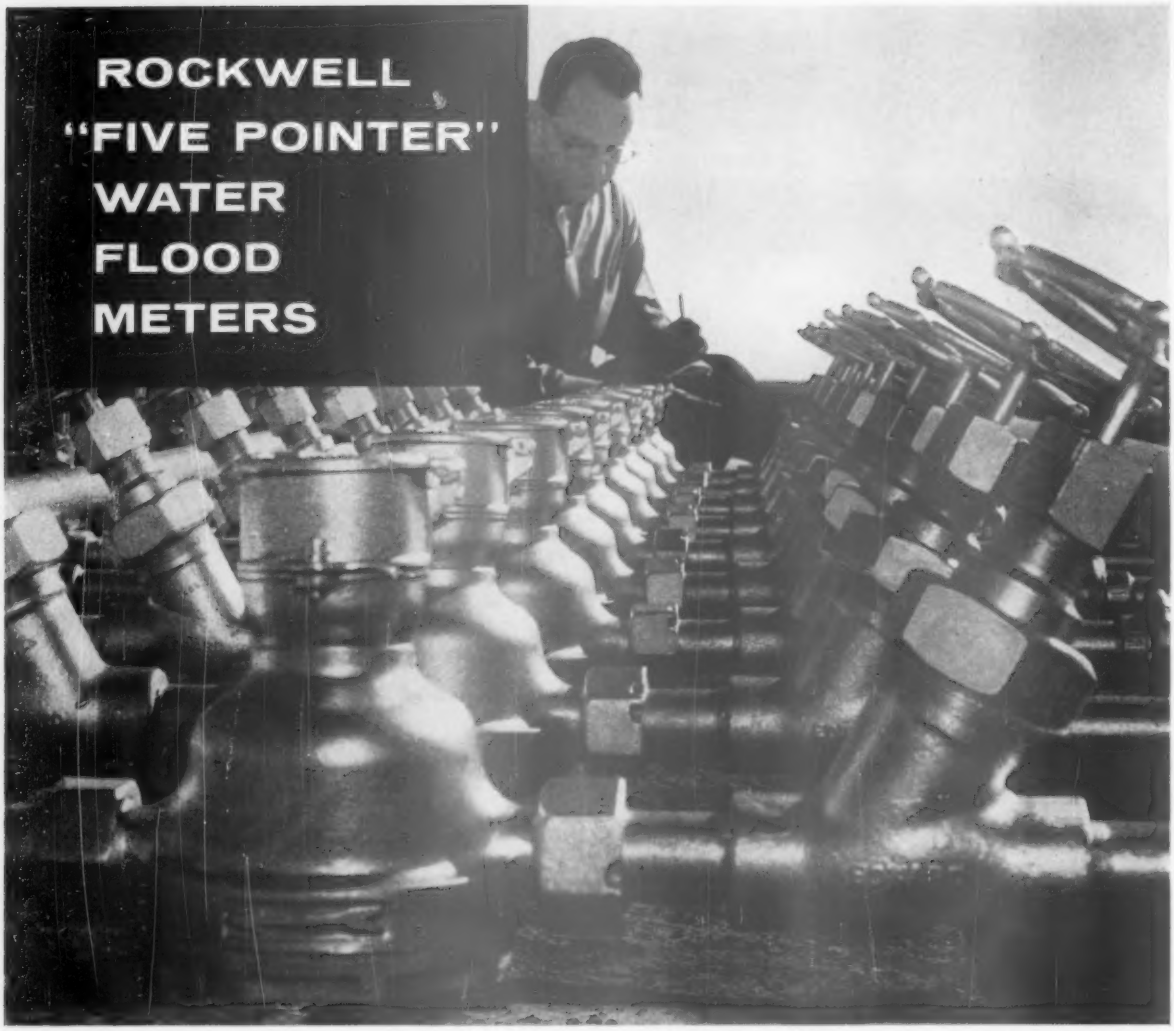

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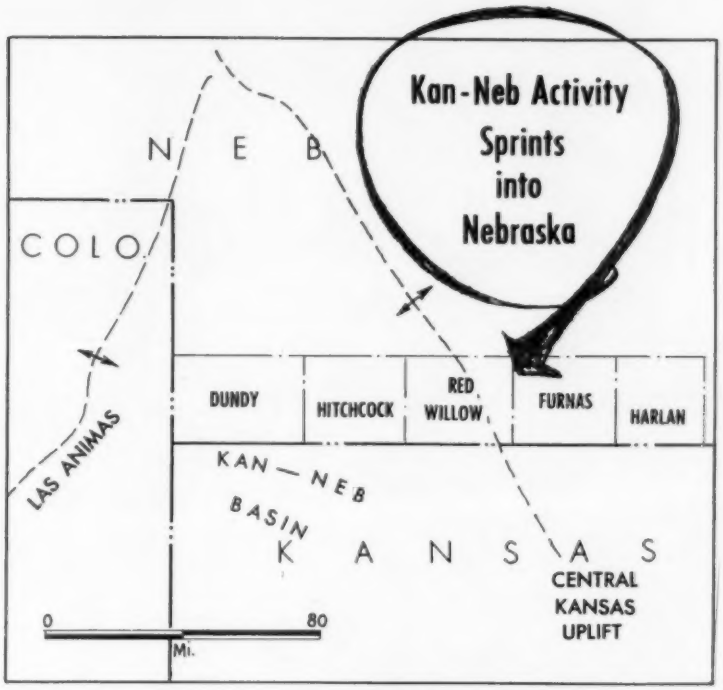
Exploration outlook

SOUTHWESTERN NEBRASKA ACTIVITY SHEET

County—	New fields 1960— 4-1-61	No. oil wells 1960— 4-1-61	Drilling 4-1-61
Dundy	1	3	4
Red Willow	4	137	45
Harlan	1	2	4
Furnas	1	1	1
Hitchcock	1	23	1
Total	**8**	**166**	**55**



NEBRASKANS are looking to their southern tier of counties for new oil, target is Pennsylvanian and Cambrian rocks.

New pays, few dusters, on Cambridge arch

SOUTHWESTERN NEBRASKA is in its busiest drilling period. Since early last year eight new oil fields have been opened in a five-county tier along the southern part of the state. As a result of these new fields, 166 oil producers have been put on the books. There are 55 wells drilling in this section with more planned for the remainder of the year. Exploratory drilling is moving out of the southern counties up and down and on both sides of the Cambridge arch, principal structural feature in southwestern Nebraska.

Success ratios are high

. . . in southwestern Nebraska drilling. There were only 11 dry holes drilled out of 79 attempts in Red Willow County last year. So far this year there have been no failures in the county, but there have been 45 producers put on production. Center of Red Willow interest is Sleepy Hollow field, a Cambrian Reagan sand producer. Most of the drilling in the county is going on here. Discovery of Reagan oil here in 1960 set off much debate as to the age of the pay sand. Many haven't decided yet whether it is basal Pennsylvanian or Reagan. At any rate, the pay has been a prolific one. Good wells are being added daily in the field. The first dual producer was completed in February at Pubco Petroleum 10-3 Wall. This well pumped 125 bbl. of oil daily from Lansing-Kansas City Pennsylvanian at 3,276-82 ft. and 200 bbl. per day from the Reagan at 3,498-3,591 ft. Sleepy Hollow has both pays and more dual completions are in the mill.

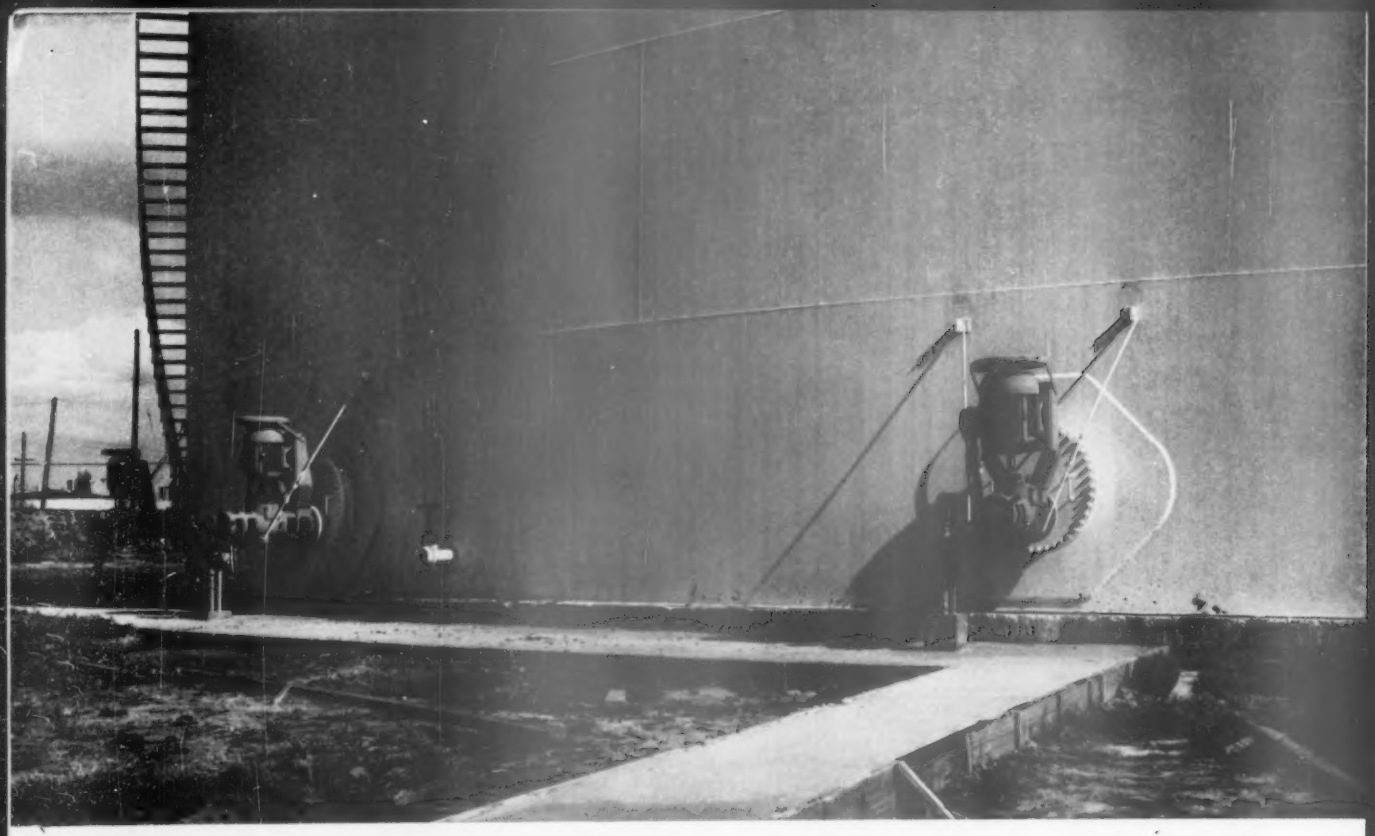
Another fast-growing Red Willow field is Silver Creek. Production is from Lansing-Kansas City. Newest well here is Texaco Inc. 1 Harsch, pumping 192 bbl. per day. Ackman field in the same county is also adding Pennsylvanian wells with clocklike regularity.

Interest is spreading

. . . outside of Red Willow County into Dundy, Hitchcock, Furnas, and Harland. New fields have been added here in the past few weeks. Dundy didn't have production until last year, and Furnas just joined the state's producing column at Exeter Drilling Co. 1 Palmer. This operator is still working on the Reagan sand after swabbing commercial oil. The well lies 8 miles east of Silver Creek field. Harlan County had one small field near Alma until this year. W. E. Wickizer 1 Furse was recently completed pumping 200 bbl. of oil daily from Lansing to spark a new drilling play here. Dundy County got its first field last year at Pierce Lake. Sunray Mid-Continent Oil Co. is now working at 1 Stroup-A, northwest offset to the Lansing-Kansas City field discovery well.

Wildcatting is now popping up in counties never heard of before on the drilling reports. There are wildcats going in Adams, Blaine, Chase, Frontier, Garfield, Greeley, Holt, Knox, Lincoln, Polk, Sherman, and Wheeler counties. Nebraska is a state of many oil possibilities. Production has been tapped in the Denver basin, the Kan-Neb basin, and Forest City basin. In between these features lie many untested prospects, particularly along the Cambridge and Chadron arches, and in the northern reaches of the oil-lacking Salina basin. These pages once stated that "what Nebraska needs is wildcats." This year's drilling campaign in the Beef State may be the beginning.

—John C. McCaslin



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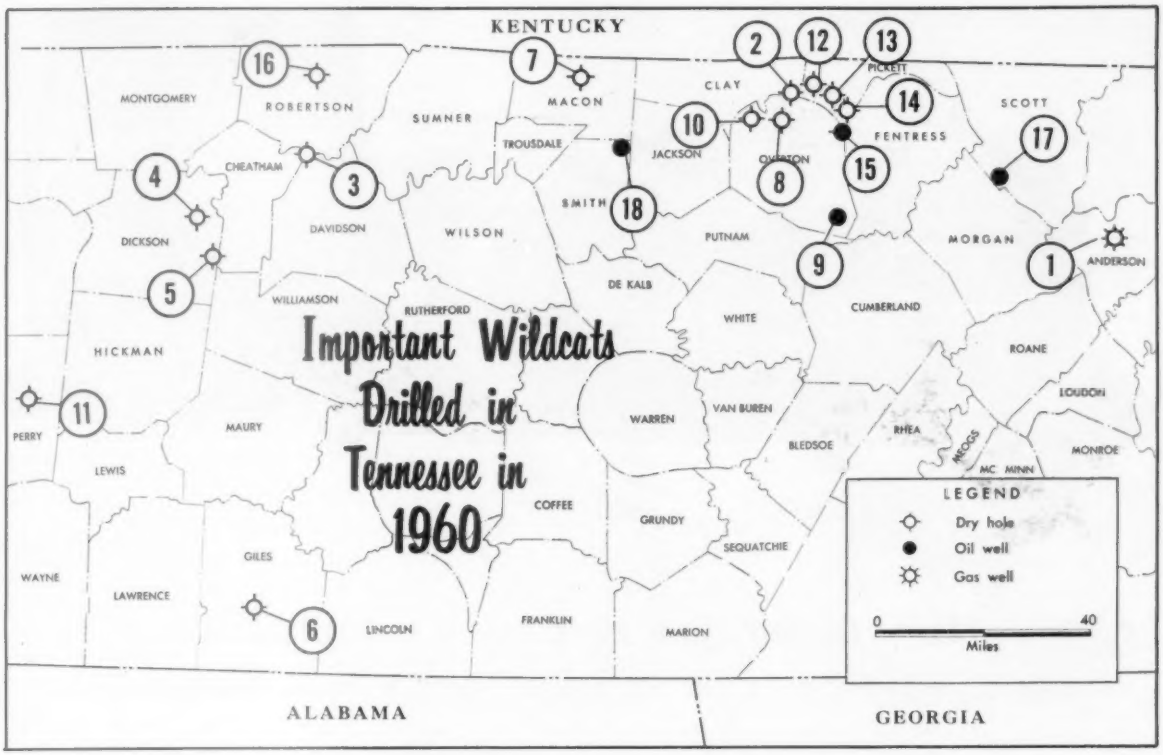


1960 IMPORTANT WILDCATS IN TENNESSEE

No. on map	County and operator	Location	Total depth	Surface formation	Deepest zone tested	Remarks
1	Anderson, Natural Gas Producers	3- 5s-64e	3,311	Lower Pennsylvanian	Lower Mississippian	Gas—small
2	Clay, Flaws et al.	17- A-51e	1,002	Lower Mississippian	Lower Ordovician	Dry and aband.
3	Davidson, Haven Oil & Gas Co.	6- 2s-32e	1,106	Lower Mississippian	Lower Ordovician	Dry and aband.
4	Dickson, Cullen et al.	17- 4s-28e	1,600±	Lower Mississippian	Upper Knox	Dry and aband.
5	Dickson, Kirby Petroleum Co.	19- 5s-28e	1,551	Lower Mississippian	Upper Knox	Dry and aband.
6	Giles, Cook et al.	23-16s-30e	1,111	Middle Ordovician	Upper Knox	Dry and aband.
7	Macon, Peter Henderson Oil Co.	6- A-43e	1,550	Upper Ordovician	Upper Knox	Dry and aband.
8	Overton, Flaws et al.	1- 1s-50e	2,000	Lower Mississippian	Upper Knox	Dry and aband.
9	Overton, Phillips et al.	11- 4s-52e	1,452	Lower Pennsylvanian	Upper Ordovician	Oil—small
10	Overton, Poppelman et al.	10- 1s-49e	1,406	Upper Ordovician	Upper Knox	Dry and aband.
11	Perry, Natural Gasoline, Inc.	15-10s-21e	1,625	Lower Mississippian	Upper Knox	Dry and aband.
12	Pickett, King Oil Co.	4- A-52e	1,800	Lower Mississippian	Upper Knox	Dry and aband.—free oil in Knox
13	Pickett, Bywaters & Loomis	15- A-53e	2,000	Lower Mississippian	Upper Knox	Dry and aband.
14	Pickett, O'Brien et al.	3- 1s-52e	1,875±	Lower Mississippian	Upper Knox	Dry and aband.
15	Pickett, Asberry & Taylor	12- 1s-53e	578	Lower Mississippian	Middle Ordovician	Oil—small
16	Robertson, Anderson et al.	1- A-32e	1,560	Lower Mississippian	Lower Ordovician	Dry and aband.
17	Scott, Petroleum, Inc.	12- 3s-59e	2,400±	Lower Pennsylvanian	Middle Ordovician?	Oil—approx. 20 bbl. oil per day
18	Smith, L. I. Freeman	2- 2s-44e	214	Middle Ordovician	Middle Ordovician	Oil—approx. 25 bbl. oil per day

Fifteen Tennessee wells tapped oil in '60

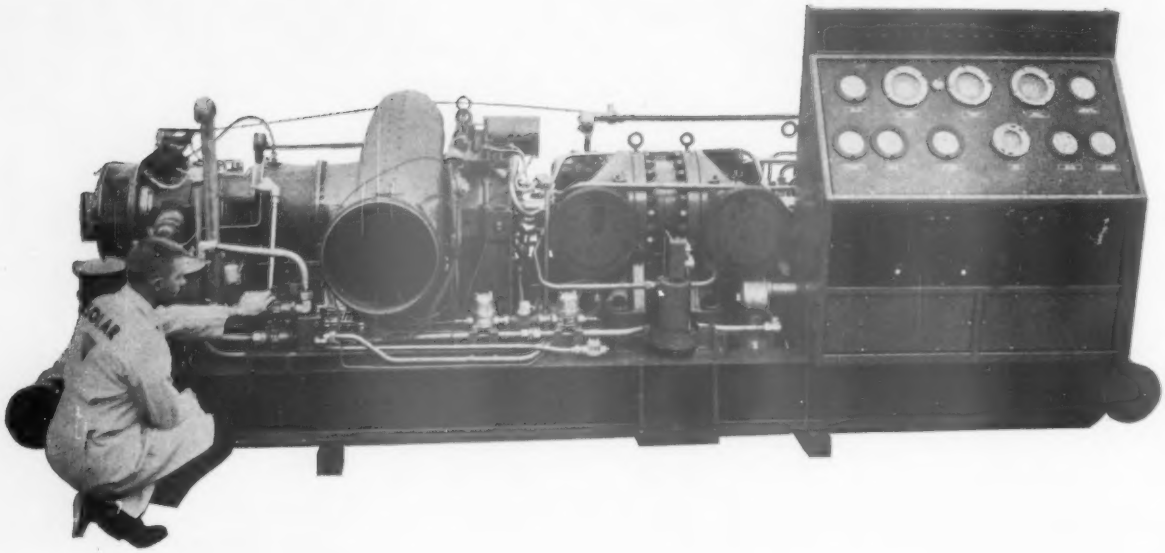
BY H. C. MILHOUS
State Geologist,
Tennessee Division of Geology

AT LEAST 130 test wells were drilled in 1960 in Tennessee. Thirteen of these made some oil, three were abandoned and two were producing 20 bbl. of oil per day or more at the end of the year. One small gas well was producing and three noncommercial wells were capped.

Developments

Activity in 1960 was much greater than in the previous year. At least 130 test wells were drilled as compared to only 72 for 1959. The pattern of drilling was unchanged, almost all exploration being in areas where previous drilling had resulted in production or good shows, and the average depth per hole was still about 800 ft.

All but 10 of the tests were drilled within 30 miles of the Tennessee-Kentucky state line; 1 was drilled in West Tennessee and none in the Valley and Ridge Province of East Tennessee. The deepest hole drilled was 3,311 ft. deep, and only five were 2,000 ft. or more in depth. The deepest stratigraphic test was the Natural Gasoline, Inc. 1 Peach in Perry County. At a total depth



New Solar gas turbine compressor offers low cost, reliability, easy maintenance

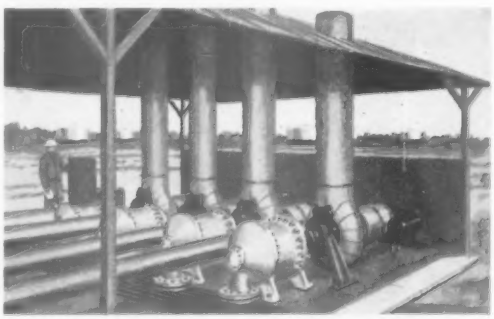
A FUNDAMENTAL ADVANCE in the centrifugal compressor field is available in Solar's new gas-turbine-driven compressor line. These units are particularly adapted for gas compression (both field and main pipeline) and for general industrial use in the low volume range up to 1500 psi.

Long-life gas turbine engines, with rotating speeds of 15,000 to 30,000 rpm, made this breakthrough possible. Driving the compressor directly at turbine speeds has permitted the design of small, high efficiency centrifugal compressors that operate in the range from 75 to 1500 cfm or 5 to 150 MM SCFD.

Features of these compressor packages include: Interchangeable compressor rotors and other parts that allow fast, low cost field changes to meet new flow and pressure requirements. Designed to start and stop in seconds, even by remote control, they are ideal for unattended operation. Small and lightweight, they are easily moved and installed on inexpensive foundations. Maintenance is unusually simple.

Detailed information on Solar centrifugal gas turbine compressors is available. Write to Dept. H-222, Solar Aircraft Company, San Diego 12, California.

Easy transportation for installation or maintenance



Multiple unit installations prevent down time

SOLAR

A subsidiary of International Harvester Company

of 1,625 ft., 330 ft. of the Knox dolomite had been penetrated. Twelve other tests reached the Knox.

Thirteen oil wells were put on the pump and eight were producing on a small scale at the end of the year. Two larger wells were producing from 20 to 25 bbl. per day. These were the Freeman 1 Anderson in Smith County, producing from the lower Nashville at 214 ft.; and the Petroleum, Inc. 1 Baker in Scott County, producing from the Ste. Genevieve at 1,570 ft.

Two wells in Fentress and three wells in Pickett County were producing from the Lower Mississippian at depths of less than 400 ft., one in Overton County was pumping a little oil from 1,475 ft. from the Lower Mississippian, and two in Pickett County were producing from the lower Nashville at about 580 ft.

Among the more interesting of the wildcats shown in the accompanying map were the following: 1 Crow Brothers, which reported shows of oil in the Wells Creek and the Upper Knox (No. 4 on map); 1 Phillips, which was drilled on a faulted anticline (No. 6); 1 Miles in Overton County, which pumped some oil from the Fort Payne after treatment (No. 9); the 1 Amonett in Pickett County, which encountered free oil in the Upper Knox (No. 12); and the 1 Baker (No. 17) and 1 Anderson (No. 18) mentioned above.

Of the 24 tests in Robertson and Sumner counties which tested part or all of the Silurian, 8 encountered shows of oil or gas and 1, in northeastern Sumner County, was pumping about 3 bbl. of oil per day at the end of the year.

Some 20 tests were drilling at the close of the year, and an increase in leasing activity in West Tennessee points toward some exploration there in 1961.

Gas Production

Total recorded gas production was 53,173 M.c.f., from 2 wells in Scott County and 15 wells in Morgan County. In addition to this there was an estimated 5 M.M.c.f. produced from Jamestown field in Fentress County and 5 M.M.c.f. from scattered wells whose production is used locally.

Oil Production

Total oil production was 19,529 bbl. Following is a breakdown by counties: Clay, 702 bbl.; Fentress, 183 bbl.; Morgan, 7,140 bbl.; Overton, 21 bbl.; Pickett, 8,714 bbl.; Scott, 2,313 bbl.; and Smith, 456 bbl.

Acknowledgment

The writer expresses his thanks for the assistance of W. D. Hardeman, state geologist of Tennessee, and for the cooperation of the drillers, operators, and refiners who furnished valuable information.

Geophysicists meet

"Geophysics and Economic Oil Finding" is the theme for the fourteenth annual midwestern exploration meeting of the Society of Exploration Geophysicists to be held April 9-11 at Skirvin Hotel in Oklahoma City. In addition to Geophysical Society of Oklahoma City, sponsor of the meeting, geophysical societies of Shreveport, Dallas, Fort Worth, Midland, and Tulsa will participate.

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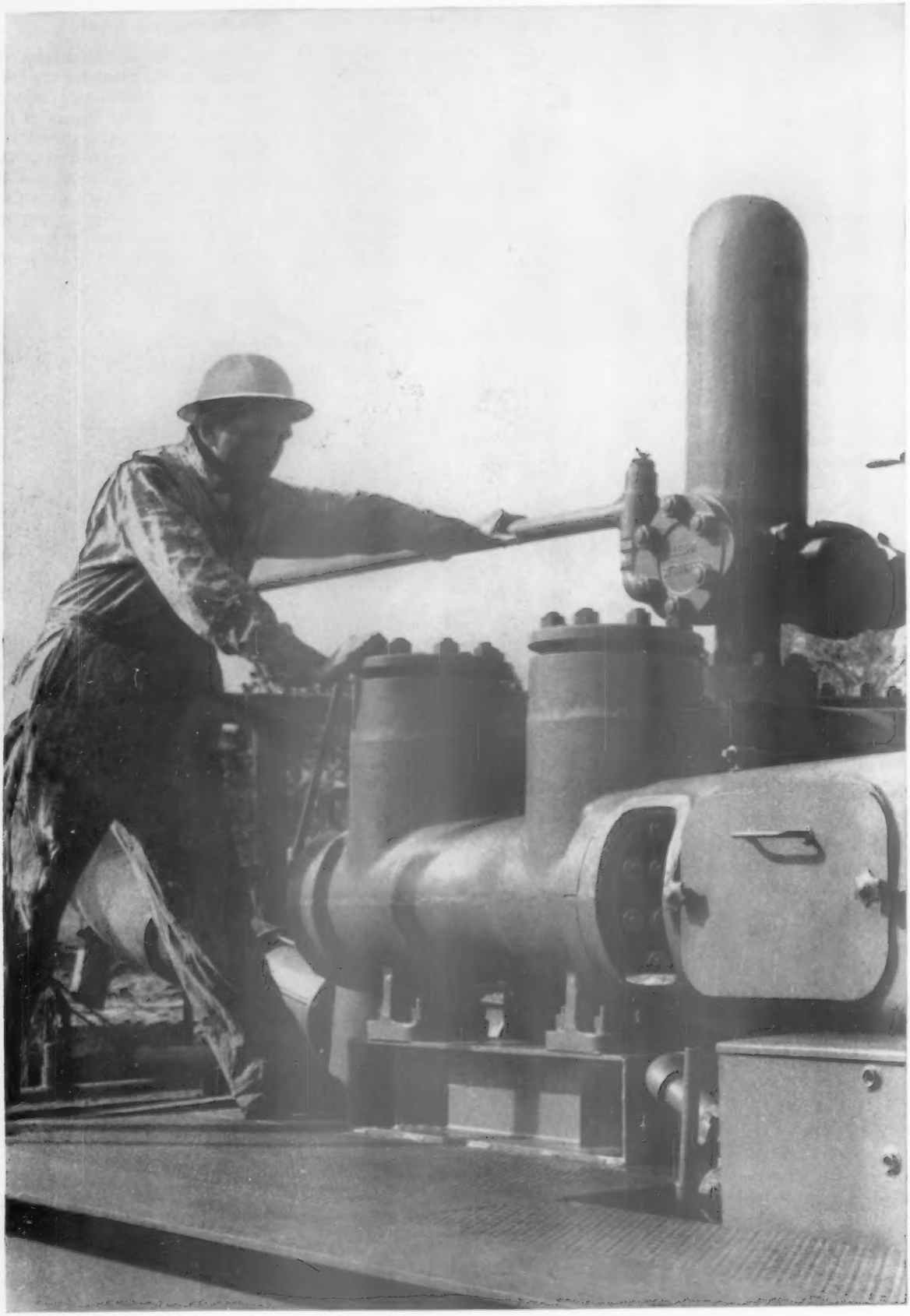

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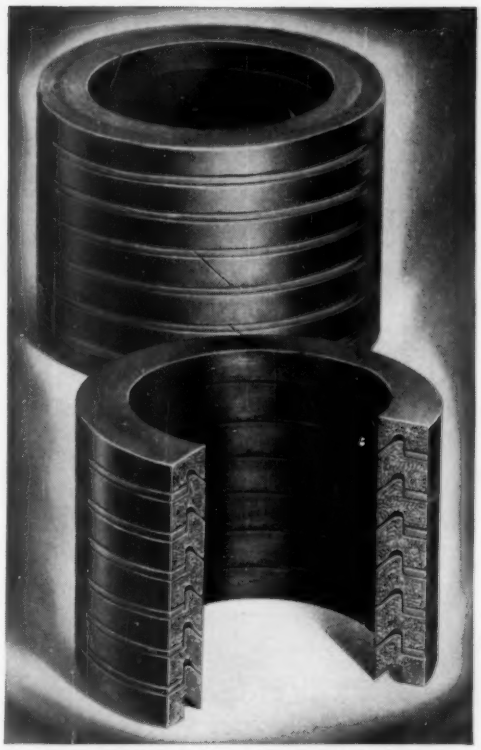

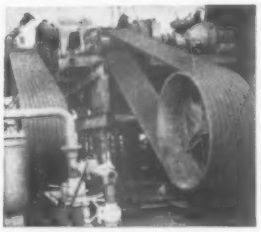

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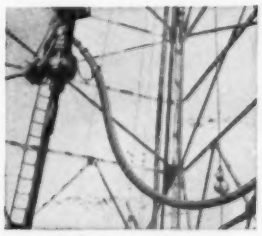

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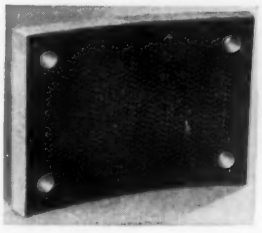

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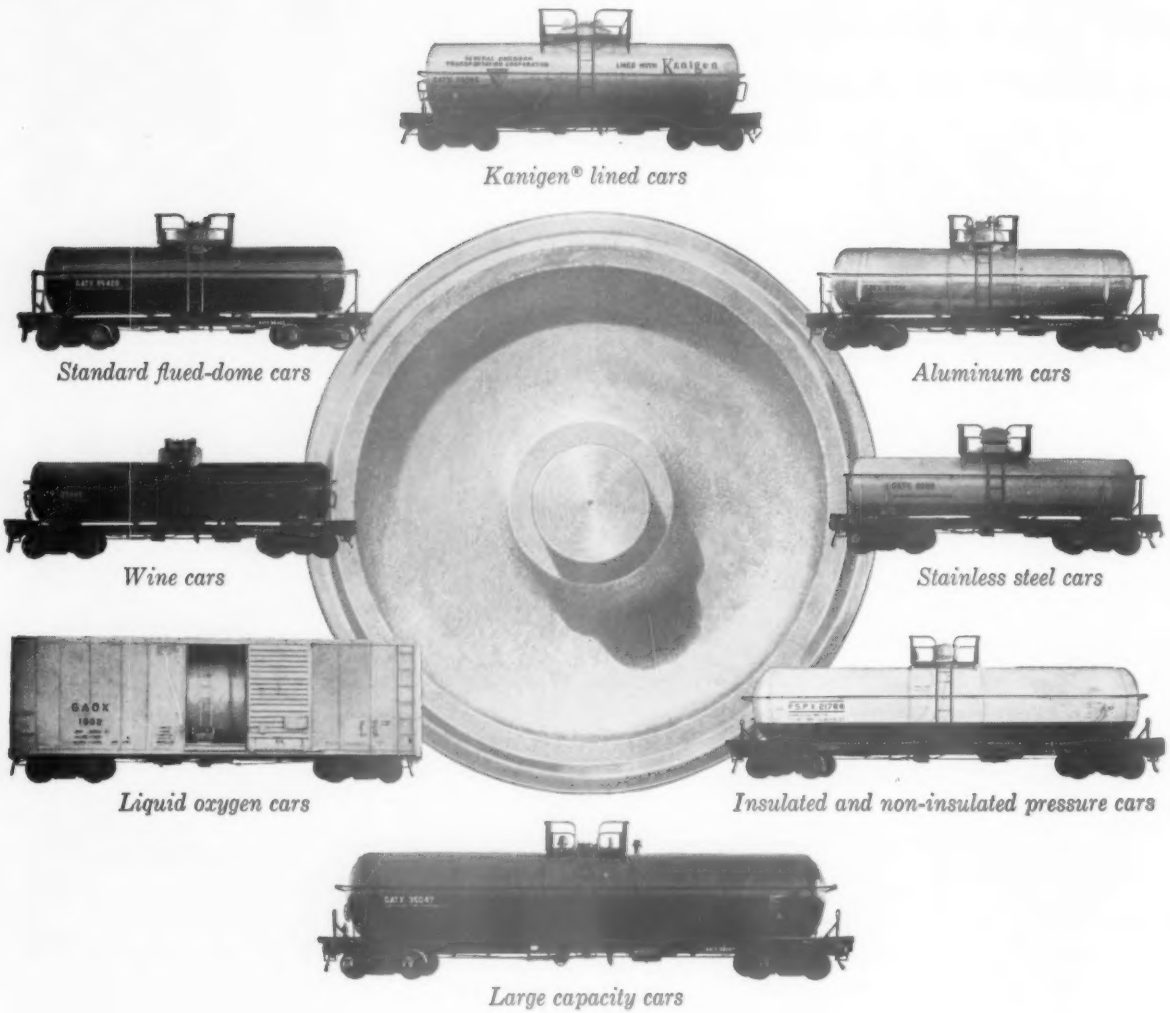

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Arkoma basin field trip planned in Mid-April

The Tulsa Geological Society and Fort Smith Geological Societies announce a joint 2-day field trip into the Arkoma basin of Oklahoma and Arkansas, April 14 and 15.

Primary aim of the trip will be to study the regional structural geology and stratigraphy of the basin, emphasizing current petroleum exploration. Contact either society for details now.

South Nebraska adds new pay zone

THE CHEROKEE Pennsylvanian is an apparent new producing horizon for the booming oil play in Nebraska's Cambridge arch country.

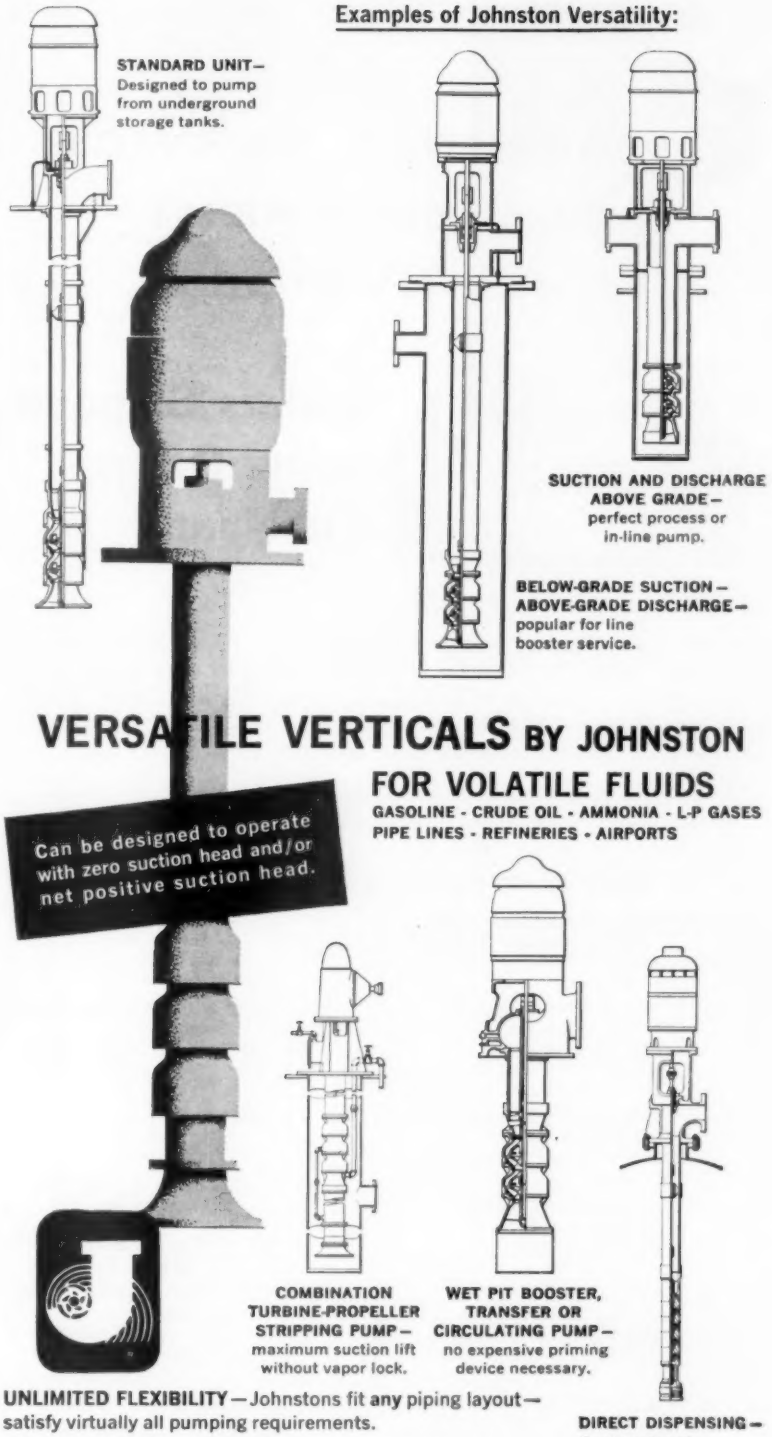
Burch Drilling Co. set casing at 3,569 ft. at 1 Haag, C NW NW 19-2n-26w, Red Willow County. Good oil recoveries were reported on three drill-stem tests below 3,497 ft. in the Cherokee. Recovery was 2,025 ft. of free oil in 2 hours at 3,497-3,530 ft. A test at 3,535-45 ft. and 3,535-50 ft. got more than 200 ft. of oil each. Some oil was also reported in Lansing - Kansas City. Location is ¼ mile southeast of Lansing-Kansas City Silver Creek field.

Dundy County. Sunray Mid-Continent Oil Co. is installing pump after swabbing oil from two intervals in Lansing-Kansas City at 1 State-B, SE NW 36-3n-38w. The well is 3 miles northwest of Pierce Lake field.

Frontier County. Unconfirmed reports state that Blair & Associates and Murfin Drilling Co. got more than 350 ft. of oil on a drill-stem test of Reagan sand at 1 Zimmer, C NW SW 33-6n-30w, Frontier County. Location is 7 miles north of Barger Lansing-Kansas City field. (See Exploration Outlook this section.)

Universal finds new pool in California's Kern

Oil production in Gosford field in Kern County, California, has been extended 4,000 ft. south by a new pool discovery drilled as a joint venture between Universal Consolidated Oil Co. and Kern County Land Co.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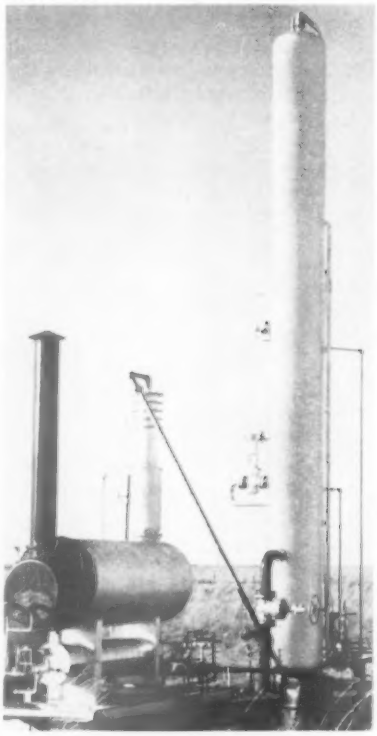

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P. O. Box 659 Tulsa, Okla.

Universal, operator on the 1,600-acre block, reports the 34-25 KCY-Coulter flowed 29.3°-gravity crude at the rate of 720 bbl. daily through an 18/64-in. choke. The flow is from the upper and lower zones of the Stevens sand. Both zones have been tested at 360 bbl. daily for the 720 bbl. total. Tubing pressure was 500 psi. and the water cut totaled on 0.1%.

The two pay zones have about 80 ft. of productive sand. The upper zone includes 39 ft. of pay between 9,770-9,809 ft. and the lower 42 ft. at 10,156-10,202 ft. There also is Upper Stevens sand behind the casing that has not been tested.

Universal has completed the well as a dual producer. The operator plans to produce the well at the rate of 480 bbl. daily, well under its initial potential. The 480-bbl. figure was picked "because it fits the trucking schedule."

The discovery is located 2,310 ft. south and 1,650 ft. east of the northwest corner of 25 - 30s - 26e. One of two offset locations are being drilled.

Saskatchewan drilling slows in March

EXPLORATION ACTIVITY in Southeast Saskatchewan has yielded some interesting developments over the past month.

At one time the southeastern sector of that province was being explored at a rate second only to Alberta. However, with only the Mississippian formation to shoot for the saturation point was reached and at the beginning of March only two rigs were working on exploratory tests within the whole of the province. That is quite a decline from the 35 that were at work in July 1957 and the 19 active during March 1959. Coupled with the fact that the zone "ran out" was the increase in activity in northeastern British Columbia and the Northwest Territories which saw many rigs moved from Southeast Saskatchewan into those promising and prolific areas. Three wells recently have indicated discovery. One of those wells has been cased for further study at a later date, another is on steady production with a fairly high rate of output and the other is regarded as fairly marginal.

Frys. Central Del Rio Oils, Ltd., pioneer exploration and development company in the area—and one which has attained a fairly high success ratio—recently uncovered new reserves in the Frys district. This strike, Central Del Rio-Mobil-Woodley - Sinclair 2-36-7-31 Frys, was drilled on LSD 2, 36-7-31w1. The Tilston member of the Mississippian was found about 70 ft. higher than a well that had a showing in that zone. That venture, also drilled by Central Del Rio was standing suspended at last report. The new strike recovered 720 ft. of gassy oil and 210 ft. of slightly oil-cut mud. The discovery horizon was encountered around the 3,100-ft. level and drill-stem test was of a 53-ft. interval immediately below.

South Carievale. Kissinger Petroleum, Ltd., came up with possibly the best strike in Southeast Saskatchewan for some time as a well drilled and operated by it was completed flowing 180 bbl. per day through restricting choke. Actually the well could do much better than

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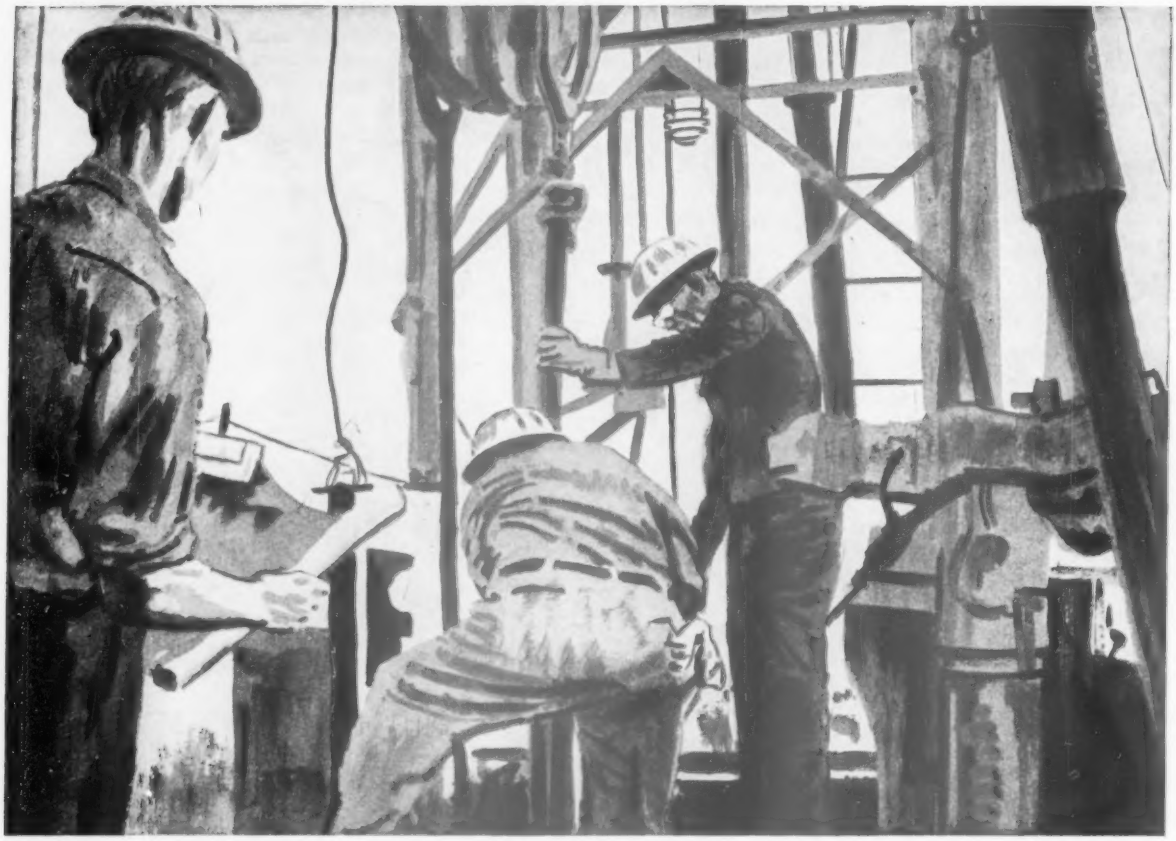

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"Shale balling up around the stabilizer puts a heavy shock on our string. If it weren't for TORQMATIC DRIVE absorbing the shock, we'd never be able to drill this hole."

That's J. W. "Frenchy" Seilhant talking. He's Drilling Super for Farr-Bolton Production Company—bosses the company's Cooper rig working in Texas' Bethany Field.

It's a small lease—so directional drilling is a must. And, because the hole must be accurate to ¼ degree, he has to make a round trip every 100 feet to check direction.

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THE MODERN DRIVE FOR MODERN EQUIPMENT

that as during the first half hour of production tests, open flow, the well gave up 20 bbl. of crude.

Kissinger Imperial 3-4-1-31 South Carievale, LSD 3, 4-1-31w1, is only ¼ mile north of the International Boundary, above North Dakota, and ¼ mile north of the International previous test, which was a wildcat abandonment.

Associated with Kissinger in this hole and another six wildcats which are part of an exploratory agreement currently being carried out, are United Canso Oils, Ltd., American Climax Petroleum Corp. and Saskatchewan Co-operative Refineries, Ltd. This particular well is on lands acquired under farmout agreement from Imperial Oil Ltd. which, with options, involves rights to about 1,700 acres of petroleum and natural-gas lease rights.

Fletwode. The recent Tidewater Oil Co. success, drilled in conjunction with Sun Oil Co., lies in the Fletwode region of the province. Varying amounts of mud, oil, and salt water were recovered during a pair of drill-stem tests in the horizon which is believed to be the Tilston member of Mississippian. Swabbing operations following perforation of a 25-ft. interval in the casing, and following acidization of the pay sector gave up 22.5 bbl. of crude in 2½ hours. That recovery was cut initially 20% by salt water and 1-5% on final swab runs.

This test was drilled on LSD 10, 13-11-4w2, and was known as the Tidewater-Sun 10-13 East Fletwode test. It lies 1 mile south of the Sun 8-24 Belleville exploratory dry hole and 12 miles northwest of oil production in Parkman oil field. Pump will likely be installed on the well for production.

Strawn discovery seen in Kent County, Texas

Flowing Strawn Pennsylvanian production is reported at Ohio Oil Co. 1 Nellis McLaury A/C 1, central Kent County, 5 miles northeast of Clairemont, Tex.

The well flowed 25 bbl. of oil per hour during tests at 6,599-6,615 ft. Location is in the W. P. Wilson Survey 7, 2 miles northeast of North Clairemont field and 3 miles south of Boomerang field.

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Alberta well begins tests

IN CANADA, Pan American Petroleum Corp. has announced that production tests have begun at its A-1 Melvin River discovery well in northern Alberta.

Following an acid fracture of the Slave Point lime, the well has been placed on pump to recover additional load fluids and to obtain information necessary to evaluate the well's potential. The significance of the strike and the surrounding area cannot be evaluated until the production tests have been completed.

The A-1 Melvin River well, located in the Caribou Mountain block where Pan American has an interest in approximately 6 million acres, is 400 miles north-northeast of Edmonton and 65 miles south of the Northwest Territories on LSD 16, 32-116-13w5. The location falls in the northeast corner of a tract farmed out to Pan American by Union Oil Co. of California.

On drill-stem test of the Slave Point at 3,857 ft., recovery was 90 ft. of mud, 180 ft. of gas and oil-cut mud, 120 ft. of mud-cut oil and 60 ft. of clean oil. A lower section of the Slave Point was cored and tested but resulted in the recovery of only salt water and mud.

The A-1 Melvin River well is one of a number of tests drilled in the area during this past winter season. Currently three rigs are on locations southwest and east of the discovery.

Anido Creek extension flows in Utah

The fifth successful completion in Utah's new Anido Creek field, San Juan County, flowed 582 bbl. per day from Ismay Pennsylvanian at 5,345-74 ft. through 26/64-in. choke.

This big new extension is Superior Oil Co. 14-7 Navajo-G, C SW SW 7-23s-25e. Location is at the northeast offset spot to the discovery well. There have been two dry holes in the field—one to the south and one northwest of the field discovery, completed in January.

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Discovery wells

CALIFORNIA

Kern County:

Universal Consolidated Oil Co.-Kern County Land Co. 34-25 KCY-Coulter, SW SE NW 25-30s-26e. Tested 360 bbl. of 29.3°-gravity crude from upper and lower zones of Stevens sands for total daily flow of 720 bbl. daily through 18/64-in. choke. Tubing pressure 500 psi. TD 10,656 ft. with perforations at 9,770-9,809 ft. and 10,156-10,202 ft. New pool discovery and 4,000 ft. southerly extension of Gosford field.

Sonoma County:

Drilling & Production Co. 5-6 Petaluma Community, SE NW NW 30-5n-6w. Flowed 550 M.c.f.d. through four ½-in. holes at 1,577 ft. through ½-in. choke. Shut-in pressure 662 psi. TD 2,034 ft. Deeper pool discovery in Petaluma gas field.

WESTERN CANADA

British Columbia:

Pacific et al. d-33-I Peejay, d-33-I-94-A-15. Triassic oil discovery. TD 3,775 ft.

Saskatchewan:

Kissinger-Imperial 3-4 South Carievale, LSD 3, 41-1-31w1. Mississippian oil discovery. TD 4,068 ft.

Tidewater-Sun 10-13 East Fletwode, LSD 10, 13-11-4w2. Mississippian oil discovery. TD 3,882 ft.

ILLINOIS

White County:

National Associated Petroleum Co. 1 Alvin G. Stein, NE NW SW 36-3s-10e. IP 25 BOPD, Benoist 2,936-53 ft. Aux Vases 3,056 ft. TD 3,202 ft.

Dee Drilling Co. 1 Lamar Williams, SE NE NW 29-4s-10e. IP 585 BOPD, O'Hara 3,129-48 ft. TD 3,223 ft.

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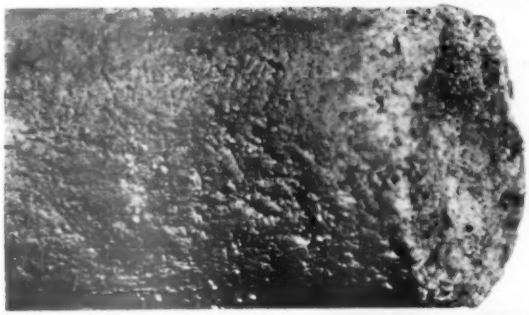

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This is another example of the persistent efforts of Schlumberger engineering. Tools and Services, both new and old, are constantly improved to do an even better job for the oil operator.

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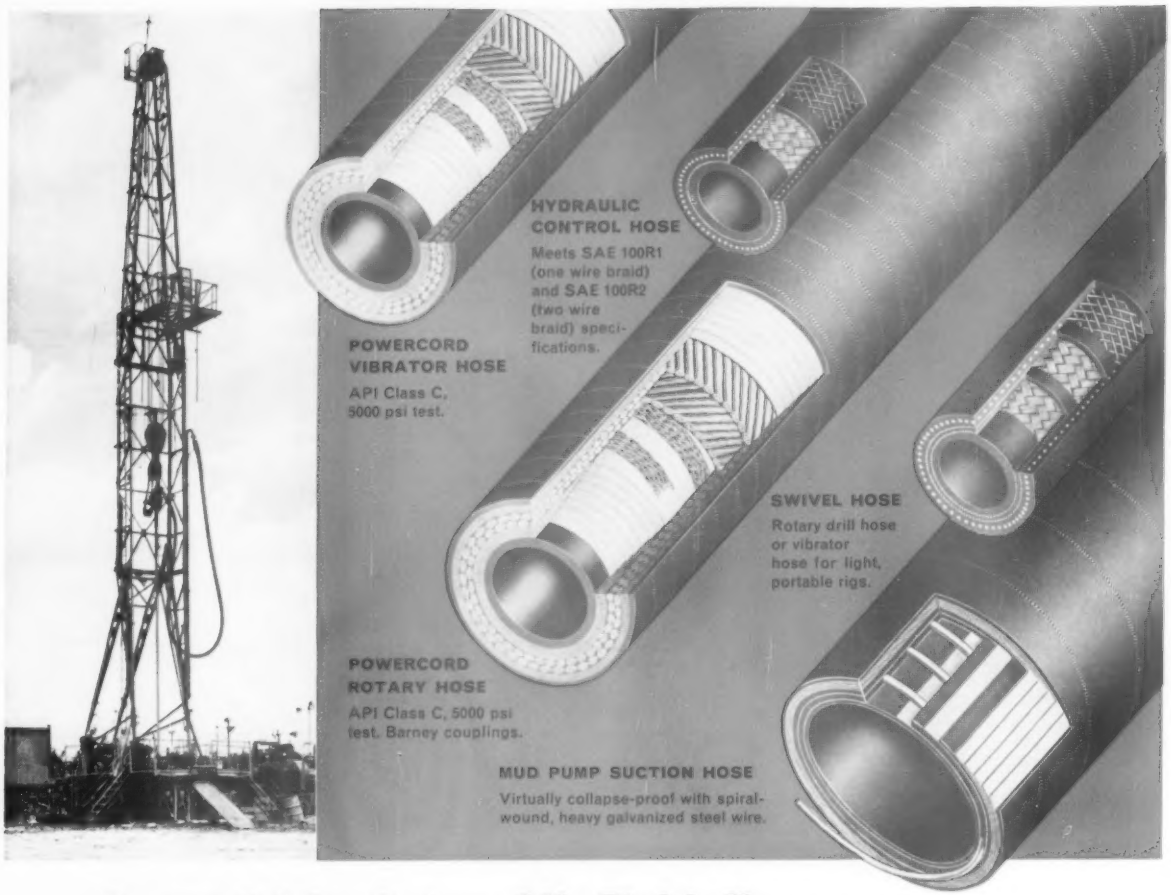
THE EYES OF THE OIL INDUSTRY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Joseph E. Morero . . . only sure thing is change.

Import of Research Stressed

. . . by Joseph Morero, Skelly senior vice president, who sees special need for advances in secondary recovery.

ONE of the surest things about the oil business is the fact that it will keep on changing.

No one can predict exactly what the industry will be like in the next few decades. But it's a safe bet that a strong accent on research will be needed if companies are to stay abreast of new developments in technology and in administrative techniques.

That's the view of Joseph E. Morero, senior vice president of Skelly Oil Co., who has recently been placed in charge of exploration and production for the big Tulsa-based firm.

Morero figures the oil business will be "touch-and-go" until sometime between 1963 and 1965.

"By that time," he says, "I think demand for world production will have increased substantially, and that both the majors and the independents will be better off."

What kind of research does he consider most vital?

"The phase that deals with the recovery of oil which wasn't obtained through primary methods," Morero replies emphatically.

"We in the industry have produced only a small part of the oil in many reservoirs. I believe the future of the American oil industry lies in getting out what's still there."

Road to Skelly . . . Morero's first interest was in mining, but he switched his attention to the oil business because he needed a job when he got married and found there was one available with an oil company.

A native of Los Angeles, Morero was raised in San Pedro, Calif., where he "spent quite a bit of time working in canneries and as a dockworker while attending school." He also went to sea for two summers.

He started studying geology and mining at Stanford University, but World War 1 interrupted his college career. He attended officer candidate school. After the war, he picked up his studies again and graduated from Stanford with a degree in geology and mining in 1922.

Morero married while he was doing graduate work at Stanford. That was when he heard about an opening for a field geologist with Standard of California.

He got the job and worked for 2 years in Montana, Texas, New Mexico, and California.

"Then I felt that I needed to know something about production," Morero recalls, "so I requested a transfer to the production department."

Two years in production work followed, mostly in California's Torrance and Baldwin Hills fields.

In 1926, Morero went back into geology and joined Skelly. He began as a geologist in the West Texas-New Mexico area, and later was promoted to district geologist. He transferred to Houston in 1932 as division geologist for the Gulf Coast and West Texas-New Mexico areas.

Morero went to Skelly's headquarters in 1934 as chief geologist. He was named vice president in charge of geology and geophysics in 1951, and was elected to the company's board of directors early in 1960. He became senior vice president last July.

Attitudes . . . Morero can be found at his desk even on Saturday mornings. And he's a firm advocate of after-hours reading to keep up with the latest happenings in the industry.

"I guess I put in 10 or 12 hours a week that way," he says.

His hobbies range from the fast pace of bowling to the serenity of gardening. He's particularly fond of hunting and fishing.

A key concept in Morero's philosophy of management:

"Surround yourself with good, competent men. That's essential."

●

Martin T. Odom has been named district manager of Amoco Australia, Ltd. in Sydney, Australia. Odom has been with Standard Oil Co. (Ind.) and affiliates since 1945. He moves to Sydney from Kansas City.

John L. Boros, section chief in the supply and distribution department of Standard Oil Co. (Ohio), has been named manager of the products-supply section in the new supply and transportation department. **William H. Nichols,** field supervisor in the crude-oil purchases and sales department, has been transferred from Tulsa to Cleveland, where he will be manager of the new crude-oil supply section.

Personals

John DeSisto, head of Mene Grande Oil Co.'s special studies section in the Caracas exploration department, has been elected president of Asociacion Venezolana de Geologia Mineria y Petroleo. DeSisto served as adviser on the board of AVGMP during the 1960-61 term. He has been in Venezuela since 1943.

Abdulaziz Wattare, acting director general of oil affairs in the Iraq Oil Ministry, has been named director general.

W. F. (Bill) Hand, vice president of Gibson Petroleum Co. in Calgary, has joined Empire Petroleum Co. in Denver as vice president in charge of marketing. The appointment is effective May 1.

Holland R. Hunter, Houston independent petroleum engineer, has joined Mayflo Oil Co., Dallas, as chief engineer. He will headquarter in Dallas. Hunter had been with Humble and Tennessee Gas Transmission before becoming an independent.

Dr. W. C. Howells, Texaco Canada, Ltd., has been elected chairman of the board of governors of Canadian Petroleum Association. **D. B. Furlong,** Producers Pipelines, has been elected first vice chairman, and **W. D. C. Mackenzie,** Imperial Oil, has ben named second vice chairman. Others elected to the board include **A. F. Beck,** Canadian Export Gas & Oil; **S. F. Bird,** Mobil Oil of Canada; **G. E. Dunlap,** Sun Oil Co.; **A. E. Feldmeyer,** Canadian Superior Oil Co.; **K. H. Gibson,** Pacific Petroleums; **Charles Hay,** Royalite Oil Co.; **G. L. Knox,** California Standard Co.; **A. M. McLachlin,** Shell Oil Co. of Canada; **F. C. Osment,** Pan American Petroleum Corp.; **G. T. Pearson,** Hudson's Bay Oil & Gas Co.; **W. L. Powell,** British American Oil Co.; **E. W. Scott,** Union Oil Co. of California; and **D. M. Tyerman,** McPherson, Leslie & Tyerman.

Leo A. Simmons, manager of the retail sales department of Standard Oil Co. (Ky.), has been elected a director. He succeeds **Charles W. Schneider,** vice president, who has retired after 44 years with the company.

George W. Field, division exploration manager in Houston for Cities Service Oil Co., has been transferred to Bartlesville, Okla., as manager of exploration, southern region, for Cities Service Petroleum Co.

E. L. Fisher has been named operating department manager at Shell Chemical Co.'s synthetic rubber division plant which will be built near Marietta, Ohio. He had been assigned to the plastics and resins division in Houston.

H. E. Christensen, vice president in charge of exploration for Texas-Zinc Minerals Corp., Texaco affiliate, has been named assistant to the general manager of Texaco's domestic producing department. He will headquarter in Houston.

M. H. Dubrow, assistant manager of Continental Oil Co.'s production department, has been promoted to manager of production. He will continue to headquarter in Houston. Dubrow was chief petroleum engineer in Ponca City, Okla., before moving to Houston in 1950. He became assistant manager of the headquarters production department in 1959.

Fred C. Moore, vice president, director, and plant manager for Hancock Chemical Co., has been named president of the company, a subsidiary of Signal Oil & Gas Co. He succeeds **W. T. Hancock,** who has been named chairman. Hancock is also senior vice president in charge of manufacturing for Signal. **S. A. Patterson** has been elected vice president and a director of Hancock Chemical. He is also vice president and assistant to Signal's senior vice president in charge of manufacturing.

E. J. Karle, manager of operations in California Oil Co.'s refining department, has been elected vice president of Caloil's eastern division. He will also become general manager of the refining department. Karle succeeds **C. E. Allen,** who has retired. Karle was an engineer at the Richmond, Calif., refinery of Standard Oil Co. of California before being assigned to Caloil, a subsidiary, in 1949.

KARLE

John F. West, Tulsa consulting geologist, has been appointed supervisor of the geological and land department of Midland Cooperatives, Inc. He will headquarter in Cushing, Okla. West was with Lion Oil division of Monsanto Chemical Co. before becoming a consultant.

Bill Williams, North Texas area field superintendent for Ambassador Oil Corp., has been promoted to assistant superintendent, water flood. He will headquarter in Fort Worth. **Jack Dement,** production foreman in the West Texas district, has been transferred to Jacksboro, Tex., where he will succeed Williams.

H. W. Manley, vice president and managing director of Jefferson Lake Petrochemicals of Canada, has been elected president of Petrogas Processing, Ltd., new company formed by 28 companies owning the majority of gas reserves in Calgary field. The company will build and operate a gas processing plant in the field. Other officers include **O. H. Blexrud,** Mobil Oil of Canada, vice president; **W. A. Friley,** Bailey Selburn Oil & Gas, vice president; **G. H. Lewis,** vice president and secretary; **R. B. MacKinnon,** Jefferson Lake Petrochemicals, treasurer-controller; **B. E. Taylor,** Mobil, assistant treasurer-controller; **E. M. Bredin,** Mobil, assistant secretary; and **H. M. Considine,** assistant secretary. Directors are Manley; Blexrud; Friley; Lewis, MacKinnon; **J. C. Rudolph,** Banff Oil; **J. E. Baugh,** Canadian Fina Oil; **W. R. Donahue,** Mobil; **K. R. Joynt,** Mobil; and **G. S. Brant,** Devon-Palmer Oils.

▶▶▶ Personals

Allen E. Behn has been named chief engineer of the new engineering division in the Lima, Ohio, chemical department of Standard Oil Co. (Ohio).

Daniel B. Purvis, Texas independent producer and attorney, has been named chairman of the Federal Petroleum Board by the Department of Interior. The board administers the Connally Act. Head office is in Kilgore, Tex.

C. R. Smith, general superintendent of production for Cities Service Petroleum Co., has been promoted to manager of production. He succeeds **J. A. Cleverley,** vice president and production manager, who has retired after 40 years with the company. **J. P. Straight,** an assistant

SMITH

STRAIGHT

general production superintendent, will succeed Smith as general superintendent. **J. C. McClure,** chief petroleum engineer in the production division, will succeed Straight. **C. J. Russell** will succeed McClure. Russell was assistant general superintendent of production for Arkansas Fuel Oil before moving to Bartlesville, Okla., earlier this year.

John V. Morgan, staff engineer in Fort Worth for Pan American Petroleum Corp., has been appointed assistant division engineer for the North Texas-New Mexico division. He succeeds **Thomas M. Curtis,** recently named Farmington, N. M., district superintendent.

Jack Gardner, administrative superintendent at Humble Oil & Refining Co.'s Bayway refinery, Linden, N. J., has been transferred to Houston as manager of fuel-products and planning in Humble's manufacturing department. **Douglas Bates,** operations superintendent at Bayway, will succeed Gardner there. **Fred Westphal,** assistant operations superintendent, will succeed Bates.

James O. (Terry) Breene, Jr., has been named manager of the new Denver division office of Winona Oil Co. of Delaware.

Rayburn L. Foster, vice president, general counsel, a director and member of Phillips Petroleum Co.'s executive committee, will retire April 25 after 32 years with the company. **William J. Zeman,** general attorney, has been nominated to succeed Foster as a director.

Charles H. Sommer, president of Monsanto Chemical Co., has been elected a director of Chemstrand Corp. Monsanto recently acquired 50% interest in Chemstrand previously held by American Viscose Corp.

Homer R. Swift, superintendent of right-of-way for Service Pipe Line Co., has retired after 27 years with the company.

Richard J. Gordon, Lake Erie district distribution engineer for Ohio Fuel Gas Co., has been promoted to Oberlin, Ohio, manager. He succeeds **Daniel L. Cronin,** who recently resigned to join General Dynamics Corp. **Horace J. Holmes,** engineer in York, Ohio, compressor station of Ohio Fuel Gas, has retired.

A. L. Klein has been named manager of transportation and supply for Republic division of Plymouth Oil Co. He heads a new department which combines the old traffic and supply and distribution departments. Klein is also general traffic manager of Plymouth Pipe Line Co.

William H. Wantuck, reservoir engineer for Gulf Oil Corp. in Morgan City, La., has joined the engineering staff of Southern Natural Gas Co. in Houston. He had been with Gulf since 1956.

Netum A. Steed, of Taubert & Steed, Wichita Falls, Tex., independent, has been reelected president of North Texas Oil and Gas Association. Other 1961 officers, all reelected, include **George W. Anderson, Jr.,** executive vice president; **George W. Graham,** George W. Graham, Inc., and **David A. Kimbell,** Allen Drilling Co., vice presidents.

Z. E. Stucky, general manager of Colombia-Cities Service Petroleum Co. in Bogata, has been appointed manager of the Mid-Continent region in Cities Service Petroleum Co.'s exploration division. He will headquarter in Bartlesville, Okla. **M. J. Wells,** who had been serving as interim Mid-Continent manager, will return to the headquarters office staff as assistant chief geologist. **Harry McMullen,** Bartlesville, has been named region development geologist. **Sam Franklin,** Midland, Tex., has been named region land man. **William M. Schulz** will continue as region exploration geologist, and **G. N. Shell** will continue as region geophysicist.

STUCKY

Edwin D. Yocky has been named construction superintendent for Shell Chemical Co.'s polyisoprene plant now under construction near Marietta, Ohio.

W. B. (Bud) Simon has joined Brown & Root, Inc., as manager of the contract-maintenance department. He will also be assistant manager of the refinery and petrochemical division.

George M. Geyer, district production superintendent for Cities Service Petroleum Co., has been elected chairman of the southwestern district of API's Division of Production. He succeeds **Henry P. Kerr,** Delhi-Taylor Oil Corp., Dallas. Kerr was elected chairman of the district advisory committee. **Jack Sallee,** Cardinal Chemical Co., Midland, Tex., has been named secretary-treasurer. Vice chairmen and their areas include **H. G. Wesberry,** Tidewater Oil Co., West Texas; **George Laflin,** Dowell division of Dow Chemical Co., southeastern New Mexico; **A. J. Dudenhoeffer,** El Paso Natural Gas Co., northwestern New Mexico; **T. C. Williams,** Honolulu Oil Corp., Texas south plains; and **John Tracey,** Sinclair Oil & Gas Co., North Texas.

Personals

C. J. Halamka has been promoted to supervising research engineer in refinery technical service at California Research Corp.'s Richmond, Calif., laboratory.

John F. Kroeger, manager of the ammonia department in Shell Chemical Co.'s ammonia division, San Francisco, has been transferred to New York as sales manager in the industrial chemicals division.

C. Stribling Snodgrass, European representative for Murphy Corp., has been named chairman and managing director of Murco Petroleum, Ltd., new Murphy marketing subsidiary with headquarters in London. **C. H. Murphy, Jr.,** is a director of the company and **L. P. T. O'Donnell** is secretary. Murco Transport Co., has also been organized as trading and transport subsidiary of Murphy Corp. Murco Transport officers are **Russell Marks,** president; Snodgrass and **E. H. Haire,** vice presidents; **W. J. Wynne,** secretary; and O'Donnell, assistant secretary. Directors of the transport company are Murphy, Snodgrass, Marks, Haire, **Myron R. Holmgren,** and **Charles J. Hoke.**

W. W. Walters, superintendent for Warren Petroleum Corp. in Monument, N. M., has been transferred to Kenedy, Tex., in the same capacity.

Dr. C. H. Kollenberg, manager of the coordination division of Humble Oil & Refining Co.'s Baytown, Tex., refinery, has been appointed assistant head of manufacturing coordination in charge of planning in the Houston manufacturing division office. **P. N. Kuehler,** petroleum products adviser to the Baytown refinery general manager, will succeed Kollenberg.

Joseph B. Netardus, operations engineer in Atlantic Refining Co.'s Dallas natural gas section, has been named superintendent of the Neale gasoline plant, Merryville, La. He succeeds **Ward Rosen,** who has been named superintendent of the Nueces Rives gas processing plant, which will be built near George West, Tex.

Tom Forgan has been named managing director of Kuwait Shell Petroleum Development Co., Ltd., the Royal Dutch-Shell company with a new offshore Kuwait exploration concession in the Persian Gulf. Forgan was general manager of the western division of Cia. Shell de Venezuela before transferring to the London office of Royal Dutch-Shell late last year.

Robert W. Olsen has been named senior project automotive engineer in American Oil Co.'s research and development department, Whiting, Ind. **Thomas M. O'Grady** has been named project chemical engineer there.

J. Russell Sherman, vice president of Lloyd Corp., Ltd., Beverly Hills, Calif., producing firm, has been elected executive vice president. Sherman was president of Oceanic Oil Co. before joining Lloyd Corp. in 1959.

Deaths

Raymond A. Miller, production superintendent for Sunset International Petroleum Corp. in California's South Tapo Canyon and Tapia fields, was killed March 20 in an auto accident near Newhall, Calif. Miller was with Tejon Hills Co. before joining Sunset in 1952.

Charles H. Lamb, 86, one of the founders of Gilcrease Oil Co., Tulsa, and retired secretary and director of the company, died March 27 in a Tulsa hospital after a year's illness. Lamb, a pioneer Oklahoman, entered the state in 1893 when the Cherokee Strip was opened.

Clarence Symes, 43, geologist with Sunray Mid-Continent Oil Co. in Oklahoma City, died March 25.

Carl E. Strong, 93, retired vice president of Continental Oil Co., died March 23 after a brief illness. Strong retired in 1929.

Harold J. Wiltse, 47, supervising dispatcher of Bakersfield, Calif., products deliveries for Standard Oil Co. of California, died March 18 after suffering a heart attack. He had been with California Standard 24 years.

Henry Raymond Sheffler, 81, retired tool pusher for Ohio Oil Co., died March 19 in a Bakersfield, Calif., hospital.

Earl Ainsworth, 57, coordinator of Northern Natural Gas Co.'s gas-supply department, died March 9. Ainsworth had been a member of the Kansas State Corporation Commission in Wichita before joining Northern Natural in 1949 in Omaha.

Norman Leeds, Jr., 59, assistant general manager of Raybestos division of Raybestos-Manhattan, Inc., Stratford, Conn., died March 12. He was a director of Raybestos-Manhattan.

William E. Boyle, 67, retired chief traffic clerk for Service Pipe Line Co., died March 28 in a Tulsa hospital. Boyle retired in 1956.

E. W. Maas, 62, president and general manager of Kwik-Mix Co., a division of Koehring Co., died March 17 in a Port Washington, Wis., hospital. He had been with Koehring for 44 years.

Edgar Allan, 47, assistant sales manager for the Happy Co.'s Tulsa area, was killed March 29 in an auto accident near Ponca City, Okla.

Malcolm Frederic Wharton, Sr., 65, Phoenix, Ariz., vice chairman of Arizona Oil and Gas Conservation Commission, died March 23 in a Chicago hospital after a long illness. Wharton had been a member of the Arizona commission since its inception. He served as it first chairman.

T. M. Chubb, newly appointed manager of natural-gas transportation and sales for Richfield Oil Corp., died March 27, the day his appointment was announced. Chubb was director of the Pacific Southwest division of H. Zinder & Associates before joining Richfield.

QUALITY

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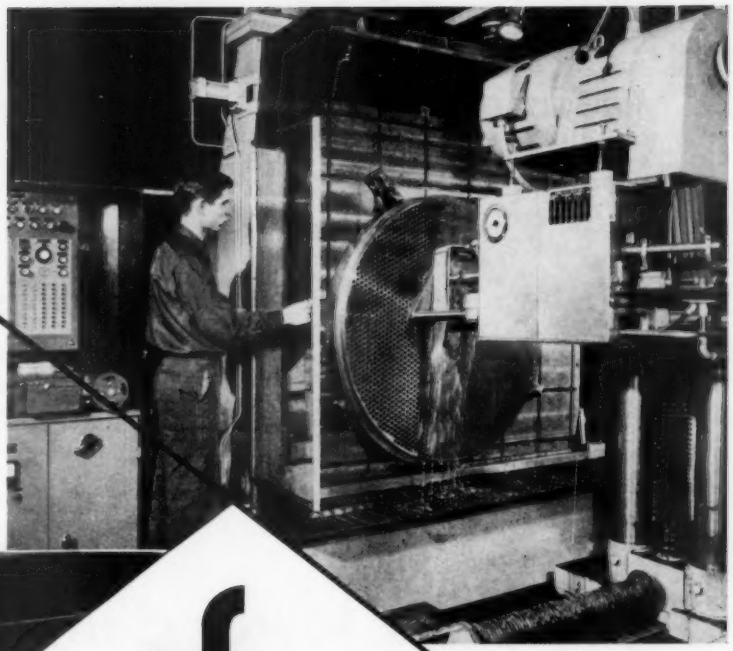

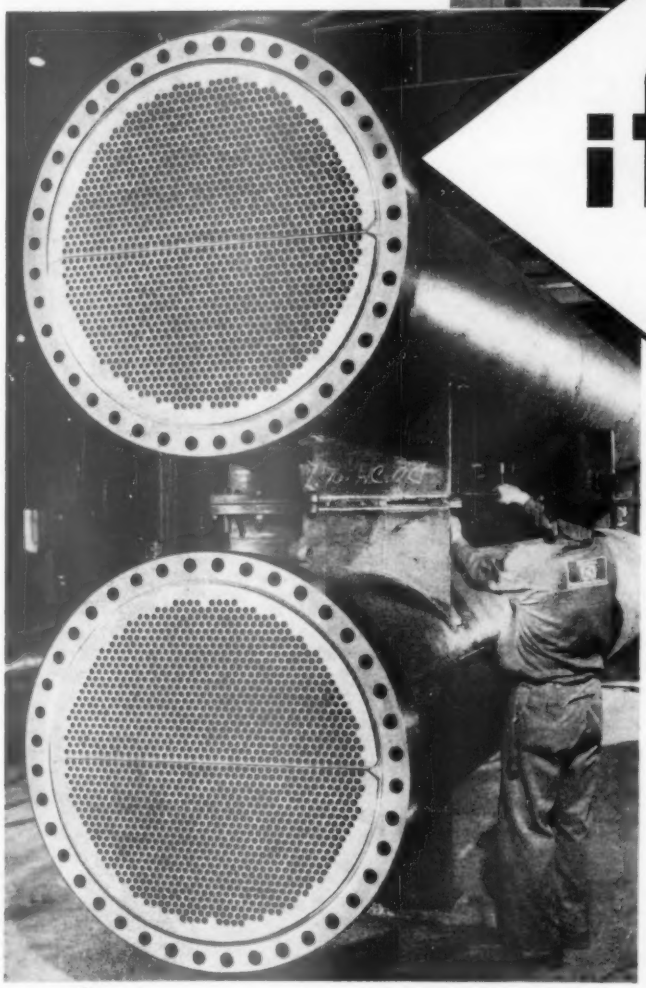

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... from electronically controlled tube hole drilling to shop stacked fit, IFC quality provides ease of handling, longer life, better performance. These techniques are not always specified, but *are* included with every purchase at IFC. Computer programmed and controlled tube hole drilling, plug gauging for roundness and alignment, stacked fit on stacked exchangers and torque-controlled roll-in of tubes are just a few of the many methods used daily to give an IFC customer the *best* in shell and tube exchangers.

For your exchanger service *emphasize* quality by letting IFC engineer your exchanger from inquiry to installation.

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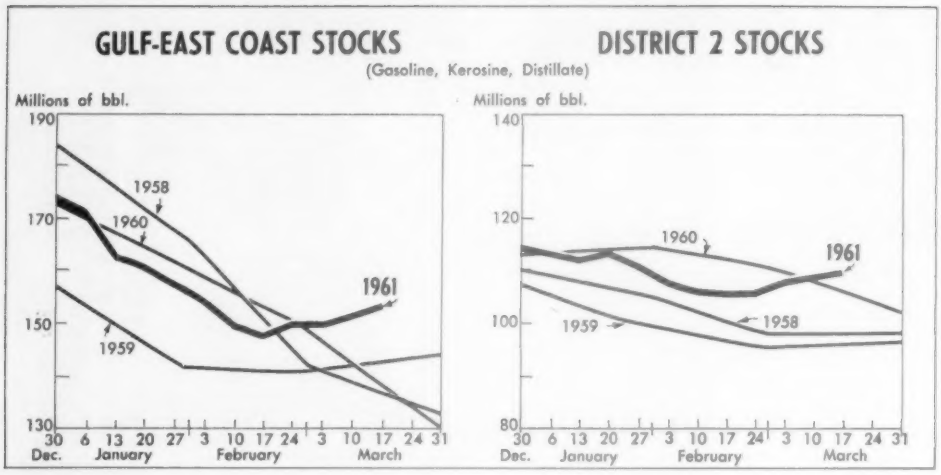


PRODUCT stock changes represent the balance between supply and demand. The abnormal upturn of clean-product stocks in recent weeks is proof that refinery input has been too high or that demand for clean products has been low.

Higher runs, lower demand, more stocks

BY JOHN C. CASPER

PRODUCT stock comparisons have made a gloomy picture in recent weeks. It is a double coat of gloom, one from each of the compared years.

Heating-oil demand was abnormally high in March 1960 because of the cold weather, but the weather did not restrict gasoline use as much as it boosted demand for fuels. Current demands are following a more normal pattern.

Demand for gasoline, kerosine, and distillate fuels at refineries in District 2 and in Gulf-East Coast areas averaged less than 4,700,000 bbl. daily for the first 16 days of March this year. For the full month last year, the average was almost 5,700,000 bbl. daily. A demand drop of a million barrels daily calls for a drastic reduction in supply.

Many companies have announced cuts in refinery runs, but the reductions were not large enough to prevent steady increases in clean-product stocks for the first half of March. The above charts show abnormal gains from the middle of February to the middle of March.

Refinery runs may be down in the last half of the month, but for the first 16 days of March, Gulf-East Coast throughput averaged 225,000 bbl. daily more than for the full month last year. In District 2, the gain was 62,000 bbl. daily.

High demand last year and high runs this year account for the big shift in product stocks. Compared with last year, stocks of major products have shifted 39 million barrels in 6 weeks.

A quick look at the highlights . . .

	LATEST WEEK	Change from WEEK AGO		Change from YEAR AGO	
Production	7,365,700	DOWN	1,000	UP	256,039
Crude stocks	235,020,000	UP	2,949,000	DOWN	20,846,000
Completions	839	UP	21	UP	182
Refinery runs	7,897,000	DOWN	146,000	DOWN	48,000
Gasoline stocks	226,668,000	UP	1,149,000	UP	681,000
Kerosine stocks	25,359,000	UP	119,000	UP	7,260,000
Distillate stocks	90,803,000	DOWN	4,577,000	UP	12,791,000
Residual stocks	42,091,000	DOWN	907,000	UP	2,239,000
Four-product stocks	384,921,000	DOWN	4,216,000	UP	22,971,000
Total imports	2,212,600	UP	64,500	UP	623,100

CALCULATED DEMAND

(Gasoline, kerosine, distillate)

Gulf-East Coast

	Jan.	Feb.	Mar.
1958	3,466	3,660	2,981
1959	3,774	3,165	3,002
1960	3,472	3,097	3,549
1961	3,793	3,521	*2,876

District 2

1958	2,054	2,145	1,716
1959	2,234	2,140	1,888
1960	2,009	2,021	2,131
1961	2,195	2,020	*1,801

*First 16 days of March.

REFINERY RUNS

(Thousands of barrels daily)

Gulf-East Coast

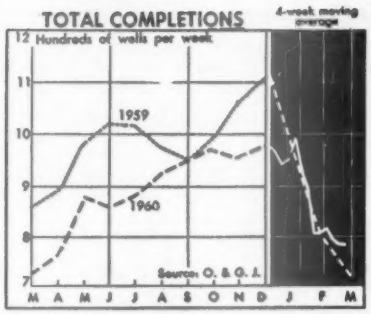
	Jan.	Feb.	Mar.
1958	3,504	3,396	3,442
1959	3,854	3,715	3,682
1960	3,751	3,682	3,620
1961	3,808	3,942	*3,845

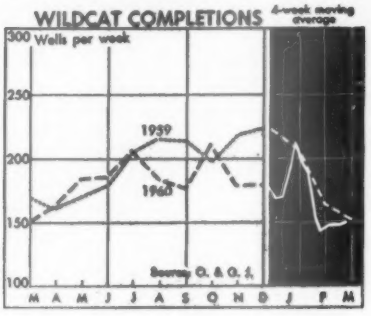
District 2

1958	2,346	2,404	2,188
1959	2,504	2,502	2,463
1960	2,564	2,453	2,371
1961	2,525	2,483	*2,433

Active Rotary Rigs

DRILLING





	3-27-61	3-20-61	3-28-60
Alabama	5	5	4
Alaska	7	7	(*)
Arkansas	15	16	12
Arizona	0	0	4
California	72	62	85
Land	68	58	83
Offshore	4	4	2
Colorado	17	20	20
Florida	0	1	2
Land	0	0	1
Offshore	0	1	1
Georgia	1	0	0
Illinois	16	17	15
Indiana	5	3	4
Kansas	77	97	77
Kentucky	2	2	4
Louisiana	269	286	296
North	33	31	28
S. Inland waters	109	112	131
S. Land	71	83	89
Offshore	56	60	48
Michigan	10	6	34
Mississippi	54	47	59
Missouri	0	0	1
Montana	18	18	12
Nebraska	30	26	22
New Mexico	87	89	102
New York	0	0	2
North Dakota	20	21	18
Ohio	6	6	4
Oklahoma	163	193	195
Pennsylvania	7	5	11
South Dakota	0	0	2
Texas	613	639	610
S. Inland waters	9	8	7
S. Land	170	158	171
Offshore	3	3	2
North	53	60	41
Panhandle	47	52	60
East	60	59	53
West Central	156	166	183
West	115	133	93
Utah	32	32	28
Washington	2	1	0
West Virginia	4	4	5
Wyoming	48	53	51
Total U. S.	**1,580**	1,656	1,679
Cum. avg. to date	1,559	1,557	1,676
Western Canada	167	178	180
Eastern Canada	0	0	2
Grand total	1,747	1,834	1,861

Hughes Tool Co. report. *Data first reported 4-4-60.

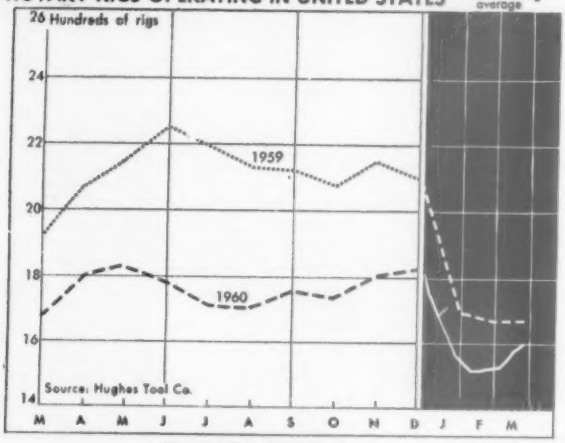
WEEKLY WELL COMPLETIONS . . . WEEK ENDED MARCH 25, 1961

	Total wells							Cum.		Total wildcats					Cum.	
	Total	Crude	Cond.	Gas	Dry	Service	Footage	1961	1960	Total	Crude	Cond.	Gas	Dry	1961	1960
Arkansas	14	7	0	2	4	1	47,600	127	134	0	0	0	0	0	25	34
California	33	25	0	2	6	0	163,683	405	309	6	1	0	1	4	63	70
Colorado	15	3	0	4	8	0	43,920	151	168	5	0	0	2	3	82	76
Illinois	64	11	0	0	6	47	104,391	455	523	6	1	0	0	5	85	146
Indiana	9	2	0	0	7	0	13,526	149	205	4	0	0	0	4	35	85
Kansas	153	81	1	3	41	27	200,030	1,252	767	13	0	0	0	13	239	245
Kentucky	12	1	0	0	11	0	11,238	323	466	1	0	0	0	1	38	55
Louisiana	69	34	0	9	26	0	571,666	796	764	17	1	0	0	16	123	103
North	23	7	0	5	11	0	86,044	291	246	7	1	0	0	6	49	44
South	35	21	0	3	11	0	365,291	397	384	8	0	0	0	8	68	53
Offshore	11	6	0	1	4	0	120,331	108	134	2	0	0	0	2	6	6
Michigan	0	0	0	0	0	0	0	157	175	0	0	0	0	0	64	55
Mississippi	5	2	1	0	2	0	56,532	128	192	1	0	0	0	1	44	66
Montana	9	0	0	0	9	0	55,642	97	59	4	0	0	0	4	44	30
Nebraska	10	5	0	0	5	0	34,713	163	171	4	0	0	0	4	70	71
New Mexico	39	22	0	9	7	1	219,078	403	448	6	2	0	1	3	75	63
West	12	5	0	7	0	0	65,647	150	148	0	0	0	0	0	18	13
East	27	17	0	2	7	1	153,431	253	300	6	2	0	1	3	57	50
New York	0	0	0	0	0	0	0	147	72	0	0	0	0	0	2	5
North Dakota	0	0	0	0	0	0	0	47	75	0	0	0	0	0	11	12
Ohio	24	8	0	8	4	4	66,338	242	265	0	0	0	0	0	10	13
Oklahoma	89	40	0	2	25	22	288,017	1,355	877	8	2	0	0	6	146	173
Pennsylvania	0	0	0	0	0	0	0	152	128	0	0	0	0	0	7	6
Texas	251	139	12	14	83	3	1,059,970	3,181	3,747	52	4	2	2	44	673	762
Dist. 1	17	6	0	0	11	0	44,901	192	259	8	0	0	0	8	75	90
Dist. 2	17	7	2	3	5	0	130,751	156	157	2	0	0	1	1	32	42
Dist. 3	14	6	2	1	5	0	86,454	239	293	1	0	0	0	1	54	58
Dist. 4	22	11	2	0	9	0	113,242	285	288	3	0	0	0	3	61	86
East	18	7	1	0	10	0	96,119	246	283	8	0	0	0	8	58	58
Dist. 7-B	42	24	0	1	17	0	116,625	439	540	14	2	0	1	11	130	154
West	56	42	2	2	9	1	267,133	796	978	6	0	0	0	6	169	150
Dist. 9	39	19	2	0	16	2	94,041	528	699	9	2	1	0	6	70	102
Dist. 10	26	17	1	7	1	0	110,704	300	250	1	0	1	0	0	24	22
Utah	5	2	0	0	3	0	20,970	57	65	3	0	0	0	3	28	22
West Virginia	14	0	0	14	0	0	40,419	229	200	0	0	0	0	0	2	1
Wyoming	20	10	0	0	10	0	138,955	248	231	5	0	0	0	5	97	95
Miscellaneous*	4	3	0	0	1	0	38,579	76	43	1	0	0	0	1	55	21
Total U. S.	**839**	395	14	67	258	105	3,175,267	10,340	10,084	**136**	11	2	6	117	2,018	2,209
Previous week	818	387	13	100	274	44	3,375,327			149	12	1	13	123		
Cum. 1961	10,340	4,717	235	1,012	3,673	703	41,712,344			2,018	171	26	94	1,727		
Cum. 1960	10,084	4,714	331	882	3,855	302	44,067,271			2,209	200	21	65	1,923		
Western Canada	43	19	0	7	16	1	218,912	563	595	15	3	0	0	12	183	178

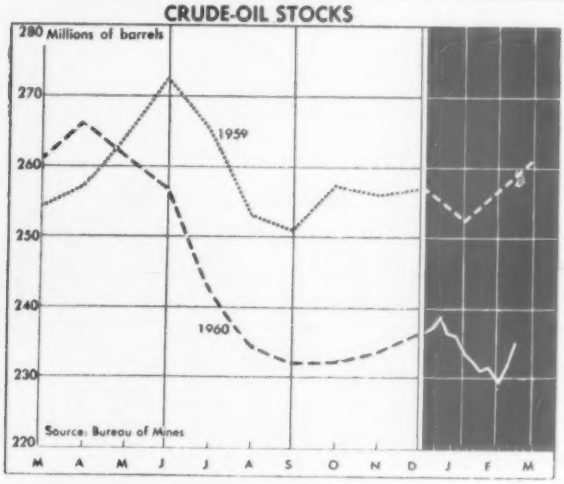
*Florida, Alabama, Alaska.

PRODUCTION

ROTARY RIGS OPERATING IN UNITED STATES



CRUDE-OIL STOCKS



CRUDE-OIL STOCKS BY STATES OF ORIGIN*
(Thousands of barrels)

	3-18-61	3-11-61	3-19-60
Pennsylvania	2,140	2,160	2,149
Other Appalachian	1,310	1,295	1,947
Illinois, Indiana, Michigan	9,081	9,158	9,316
Nebraska and North Dakota	3,231	3,031	2,653
Kansas	9,297	9,083	9,241
Oklahoma	15,448	14,647	16,395
Arkansas	1,759	1,689	1,929
Louisiana	18,054	18,297	18,970
North	3,107	3,047	3,150
South	14,947	15,250	15,820
Mississippi, Alabama, Florida	1,982	1,805	2,995
New Mexico	7,211	7,329	7,675
Texas	97,883	96,874	111,574
East Texas	8,331	8,493	8,507
West Texas	45,438	44,318	50,435
Texas Gulf	16,444	16,381	20,149
Other Texas	27,670	27,682	32,483
Wyoming	16,951	17,040	17,234
Other Rocky Mountain	9,482	9,928	9,686
California	24,780	24,520	29,461
Foreign	†16,411	15,215	14,641
Total	**235,020**	232,071	255,866

*Bureau of Mines. †Includes 5,443,000 bbl. in California.

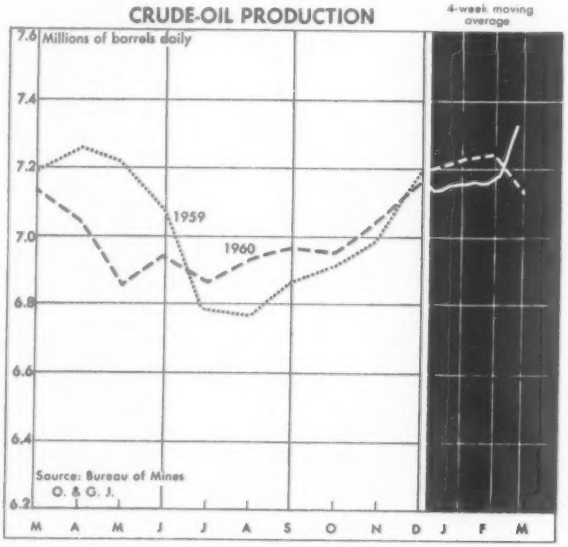
DAILY AVERAGE PRODUCTION FOR WEEK

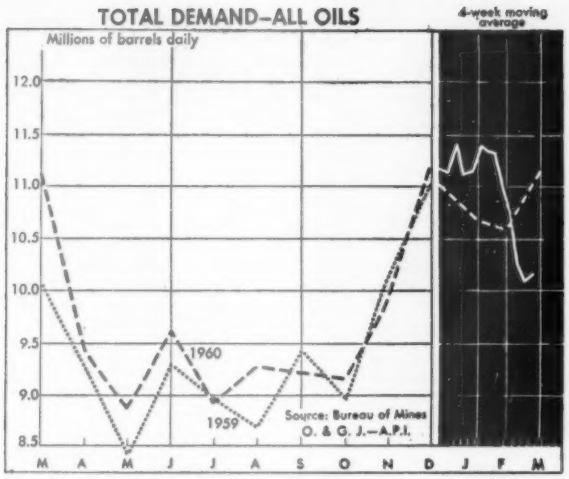
	March 25, 1961			March 18
	Crude oil	Lease condensate	Total	total
Alabama	19,250		19,250	20,175
Alaska	10,000		10,000	10,000
Arkansas	77,400	150	77,550	75,750
California	829,000		829,000	828,000
Colorado	131,600		131,600	132,500
Eastern	38,400		38,400	40,500
Florida	1,025		1,025	1,025
Illinois	209,700		209,700	209,800
Indiana	31,200		31,200	31,400
Kansas	†313,100		†313,100	†314,375
Kentucky	56,100		56,100	56,300
Louisiana	997,850	155,800	1,153,650	1,156,300
North	101,850	5,800	107,650	110,300
South	896,000	150,000	1,046,000	1,046,000
Michigan	53,400		53,400	52,200
Mississippi	146,450	4,525	150,975	150,975
Montana	82,000		82,000	80,100
Nebraska	67,500		67,500	68,400
Nevada	400		400	400
New Mexico	299,000	8,500	307,500	307,500
North Dakota	65,600		65,600	65,000
Oklahoma	†544,750		†544,750	†527,700
Texas	2,658,000	100,150	2,758,150	2,758,150
Dist. 1	44,000	3,700	47,700	47,700
Dist. 2	117,000	8,800	125,800	125,800
Dist. 3	326,000	42,000	368,000	368,000
Dist. 4	192,000	14,000	206,000	206,000
Dist. 5	29,000	500	29,500	29,500
Dist. 6	123,000	9,000	132,000	132,000
East Texas field	142,000		142,000	142,000
Dist. 7-B	134,000	500	134,500	134,500
Dist. 7-C	123,000	3,850	126,850	126,850
Dist. 8	1,130,000	12,000	1,142,000	1,142,000
Dist. 9	192,000	3,800	195,800	195,800
Dist. 10	106,000	2,000	108,000	108,000
Utah	80,400		80,400	94,300
Wyoming	383,700		383,700	385,100
Others	‡750		‡750	‡750
Total U. S.	7,096,575	269,125	**7,365,700**	7,366,700
Change from prev. week, down			**1,000**	
Canada	†553,200		†553,200	†516,500

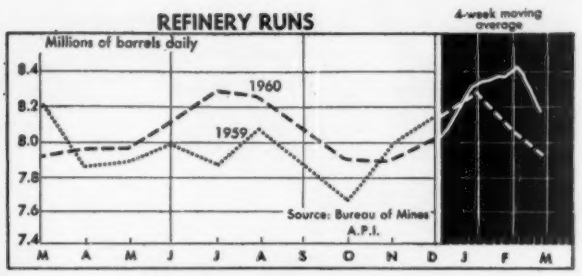
Total U. S. prod., January 1-March 25 ..... 606,568,700 bbl.
Same period last year (crude plus cond.) ..... *604,867,700 bbl.

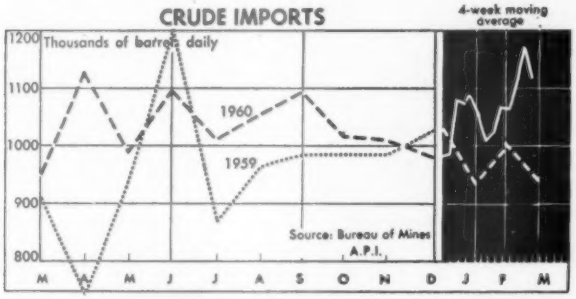
*Includes 19,295,700 bbl. condensate. †Week ended previous Monday. ‡South Dakota and Arizona.

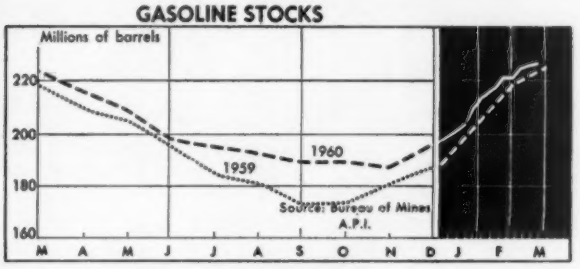
CRUDE-OIL PRODUCTION

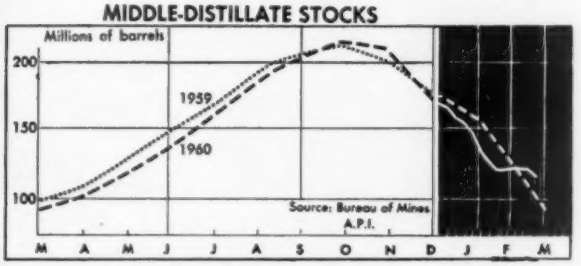


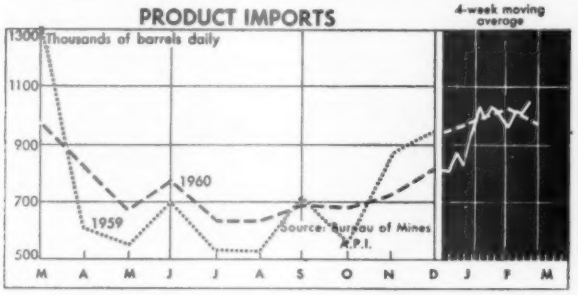


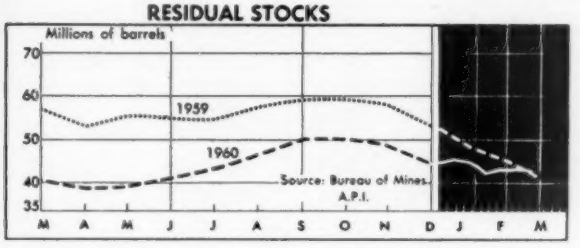












API REFINERY REPORT—MARCH 24, 1961

(Thousands of barrels)

District—	Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.	Stocks‡ Gaso.†	Kero.	Dist.	Resid.	Bureau of Mines, March 1960 Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.
East Coast	1,133	510.6	24.1	284.0	158.7	50,407	10,570	28,796	12,285	1,111	525.4	34.1	343.9	170.7
Appalachian:														
Dist. 1	103	41.6	2.6	23.9	11.6	6,209	667	2,115	583	100	39.1	4.4	21.4	12.7
Dist. 2	97	49.0	5.0	20.4	15.3	3,259	414	1,109	399	102	43.6	8.8	15.8	17.1
Ind., Ill., Ky.	1,443	774.8	74.4	302.8	184.0	40,902	4,197	16,150	5,350	1,468	734.5	77.3	316.9	210.0
Minn., Wis., Dak.	128	62.6	5.6	32.4	19.7	7,029	613	4,573	635	116	55.5	5.8	26.5	19.8
Okla., Kans., Mo.	667	360.6	14.6	176.6	15.8	21,460	1,149	8,411	913	685	380.2	13.0	170.9	43.5
Inland Texas	317	213.8	12.6	50.9	16.4	8,518	499	1,435	2,497	286	211.6	8.9	51.8	19.2
Texas Gulf Coast	1,894	993.6	146.5	448.7	160.3	33,098	2,835	7,473	4,359	1,864	940.9	124.1	418.3	136.5
La. Gulf Coast	619	329.6	43.8	119.0	43.0	11,663	1,961	3,537	1,246	645	358.7	52.1	142.3	44.2
N. La. and Ark.	118	73.4	7.6	20.6	7.7	5,965	490	2,104	141	100	65.8	4.0	21.8	7.1
Rocky Mountain:														
New Mexico	25	11.7	0.3	6.9	2.6	745	33	162	98	25	12.5	0.5	4.1	2.8
Other Rocky Mt.	261	119.8	2.0	60.1	28.3	7,956	371	2,246	993	280	130.1	3.4	64.4	33.7
West Coast	1,092	533.3	37.6	143.8	285.0	29,457	1,560	12,692	12,592	1,135	539.6	29.9	198.4	284.8
Mar. 24, 1961	7,897	4,065.4	376.7	1,690.1	948.4	226,668	25,359	90,803	42,091	7,917	4,037.5	366.3	1,796.5	1,002.1
Mar. 17, 1961	8,043	3,990.3	404.9	1,859.1	920.9	225,519	25,240	95,380	42,998	.....	.....	.....	.....	.....
Mar. 25, 1960	7,945	4,000.4	375.7	1,835.1	1,039.7	225,987	18,099	78,012	39,852	.....	.....	.....	.....	.....

*At refineries including natural blended. †Finished and unfinished ‡At refineries, bulk terminals, in transit, and in pipelines.

CRUDE-OIL PRICES

GRAVITY SCHEDULE

	Signal Hill, Calif.	Oklahoma	West Tex. (sour)	West Tex. (Inter.)	No.* Texas	Texas Refugio Light	Bayou Sale (La.)	Denver Julesburg	Wyo. (sour)
14-14.9	$1.86	....	....	....	....	....	....	....	....
15-15.9	1.93	....	....	....	....	....	....	....	$1.81
16-16.9	2.00	....	....	....	....	....	....	....	1.86
17-17.9	2.06	....	....	....	....	....	....	....	1.91
18-18.9	2.13	....	....	....	....	....	....	....	1.96
19-19.9	2.20	....	(†)	....	....	....	....	....	2.01
20-20.9	2.27	$2.49	$2.35	$2.61	$2.29	$2.95	$2.90	$2.58	2.06
21-21.9	2.33	2.52	2.38	2.63	2.33	2.97	2.92	2.60	2.11
22-22.9	2.40	2.55	2.41	2.65	2.37	2.99	2.94	2.62	2.16
23-23.9	2.46	2.58	2.44	2.67	2.41	3.01	2.96	2.64	2.21
24-24.9	2.53	2.61	2.47	2.69	2.45	3.03	2.98	2.66	2.26
25-25.9	2.60	2.64	2.50	2.71	2.49	3.05	3.00	2.68	2.31
26-26.9	2.67	2.67	2.53	2.73	2.53	3.07	3.02	2.70	2.36
27-27.9	2.74	2.70	2.56	2.75	2.57	3.09	3.04	2.72	2.49
28-28.9	2.81	2.73	2.59	2.77	2.61	3.11	3.06	2.74	2.54
29-29.9	2.87	2.76	2.62	2.79	2.65	3.13	3.08	2.76	2.59
30-30.9	2.93	2.79	2.65	2.81	2.69	3.15	3.10	2.78	2.63
31-31.9	3.00	2.82	2.68	2.83	2.73	3.17	3.12	2.80	2.67
32-32.9	3.06	2.85	2.71	2.85	2.77	3.19	3.14	2.82	2.71
33-33.9	3.12	2.88	2.74	2.87	2.81	3.21	3.16	2.84	2.75
34-34.9	3.17	2.91	2.77	2.89	2.85	3.23	3.18	2.86	2.79
35-35.9	3.22	2.94	2.80	2.91	2.89	3.25	3.20	2.88	2.83
36-36.9	3.27	2.97	2.83	2.93	2.93	3.27	3.22	2.90	2.87
37-37.9	3.31	2.99	2.86	2.95	2.95	3.29	3.24	2.92	2.89
38-38.9	....	3.01	2.89	2.97	2.97	3.31	3.26	2.94	2.91
39-39.9	....	3.03	2.92	2.99	2.99	3.33	3.28	2.96	2.93
40-44.9	....	3.05	2.95	3.01	3.01	3.35	3.30	2.98	2.95

*Cooke, Grayson, Montague. †Two buyers announced increase.

FLAT PRICES

Louisiana:
- Sweet Lake $3.00

Texas:
- East Texas 3.05-3.25
- Conroe 3.23-3.53
- Van 3.08

Pennsylvania Grade:
- Bradford $4.75-4.80
- Middle District 4.52
- Southwest Pennsylvania 4.25
- West Virginia 4.17
- Buckeye Grade 4.08

Illinois Basin **3.00-3.05**

FOREIGN

Middle East, Persian Gulf: (cargoes f.o.b. lifting port)
- Arabian, 34.0°-34.9°, Ras Tanura $1.80
- Iranian, 34.0°-34.9°, Bandar Mashur 1.78
- Iranian, 34.0°-34.9°, Abadan 1.73
- Iraq, 35.0°-35.9°, Fao 1.72
- Kuwait, 31.0°-31.9°, Mina-al-Ahmadi 1.59
- Qatar, 41.0°-41.9°, Umm Said 1.95

Middle East, E. Mediterranean:
- Arabian, 34.0°-34.9°, Sidon $2.17
- Iraq, Mosul-Kirkuk, 35.0°-35.9°, Tripoli 2.19

Far East (cargoes, f.o.b. Lutong, Sarawak):
- Seria Light, 36° 2.42

Canada:
- Leduc-Woodbend $2.53
- Redwater (Alta.) 2.42
- Weyburn (light) 2.06
- Midale C 1.70

Venezuela:
- Cumbarebo, 47°-47.9°, Tucupido 3.34
- San Joaquin, 40°-40.9°, Puerto La Cruz 3.08
- Oficina, 35°-35.9°, Puerto La Cruz 2.80
- Tia Juana medium, 26°-26.9°, Amuay* 2.30
- Quiriquire, 16.0°-16.4°, Caripito 2.10
- Lagunillas heavy, flat, Las Piedras* 2.10
- Bachaquero, flat, 15°-16°, Las Piedras* 1.88

Prices for all crudes of 24° or lighter vary 2 cents per degree change, up or down. All crudes heavier than 24° vary 2.5 cents per half-degree gravity change.

*Also available at La Salina at 3 cents per barrel less.

TANKER RATES (Long Ton)

(Latest reported spot fixtures)

- Gulf-NY, dirty (ATRS—27.5%) $2.07
- ★ PG-Japan, dirty (USMC—70%) 3.06
- ★ Carib.-NY, dirty (ATRS—60%) 1.10
- ★ PG-UK, dirty (Scale—52.5%) (29s. 0d.) 4.06
- ★ PG-NY, dirty (ATRS—65%) 4.17

★Denotes change from previous week.

REFINED PRODUCTS

Following quotations are realistic spot prices for refined products moving interstate on Wednesday each week. They may differ from refiners' posted prices and should not be considered as postings.

Light-product prices are in cents per gallon. Residual and crude prices are dollars per barrel. Crude prices are at the well unless otherwise listed.

GASOLINE*

Mid-Continent (Group 3):
- Regular (91 octane) .. 11.75-12.00
- Premium (99 octane). 14.50-14.75
- Natural gasoline (26-70) 4.5
- Breckenridge 4.0

Gulf Coast (cargoes for coastwise or export movements):
- Regular (90 octane) .. 10.50-11.00
- Regular (92 octane) .. 10.75-11.25
- Premium (98 octane). 11.75-12.25

California (rack) Los Angeles:
- Regular (90 octane) 11.00
- Premium (94 octane) 12.00
- Premium (100 octane) 13.50

Caribbean area (cargoes):
- Regular (87 octane) 9.50
- Premium (97 octane) 11.625

*Quotations are for octanes shown. Prices usually vary with octane ratings within the regular, premium, and aviation grades.

KEROSINE AND DISTILLATE

Mid-Continent (Group 3):
- Kerosine 42-44 ....10.375-10.625
- Diesel oil (58 d.i. and above) 10.00-10.25
- Distillate No. 1 ..... 10.00-10.25
- Distillate No. 2 ..... 9.00-9.25

Gulf Coast (cargoes):
- Kerosine 41-43 .... 9.875-10.25
- Distillate No. 2 .... 9.25-9.50

New York Harbor (barges):
- ★ Kerosine 42-43 ..... 11.40
- ★ Distillate No. 2 ..... 10.40
- ★ Diesel fuel, 48-52 d.i. 10.55

Caribbean area (cargoes):
- Distillate No. 2 ..... 8.625

RESIDUAL FUEL (Bbl.)

Mid-Continent (Group 3):
- Residual fuel (max. 1% S) .. $1.90

Gulf Coast (cargoes):
- ★ Bunker C fuel 2.20

New York Harbor (barges):
- Bunker C fuel 2.52

Caribbean (cargoes):
- Bunker C 2.00

California (rack):
- Bunker C fuel, Los Angeles 2.25

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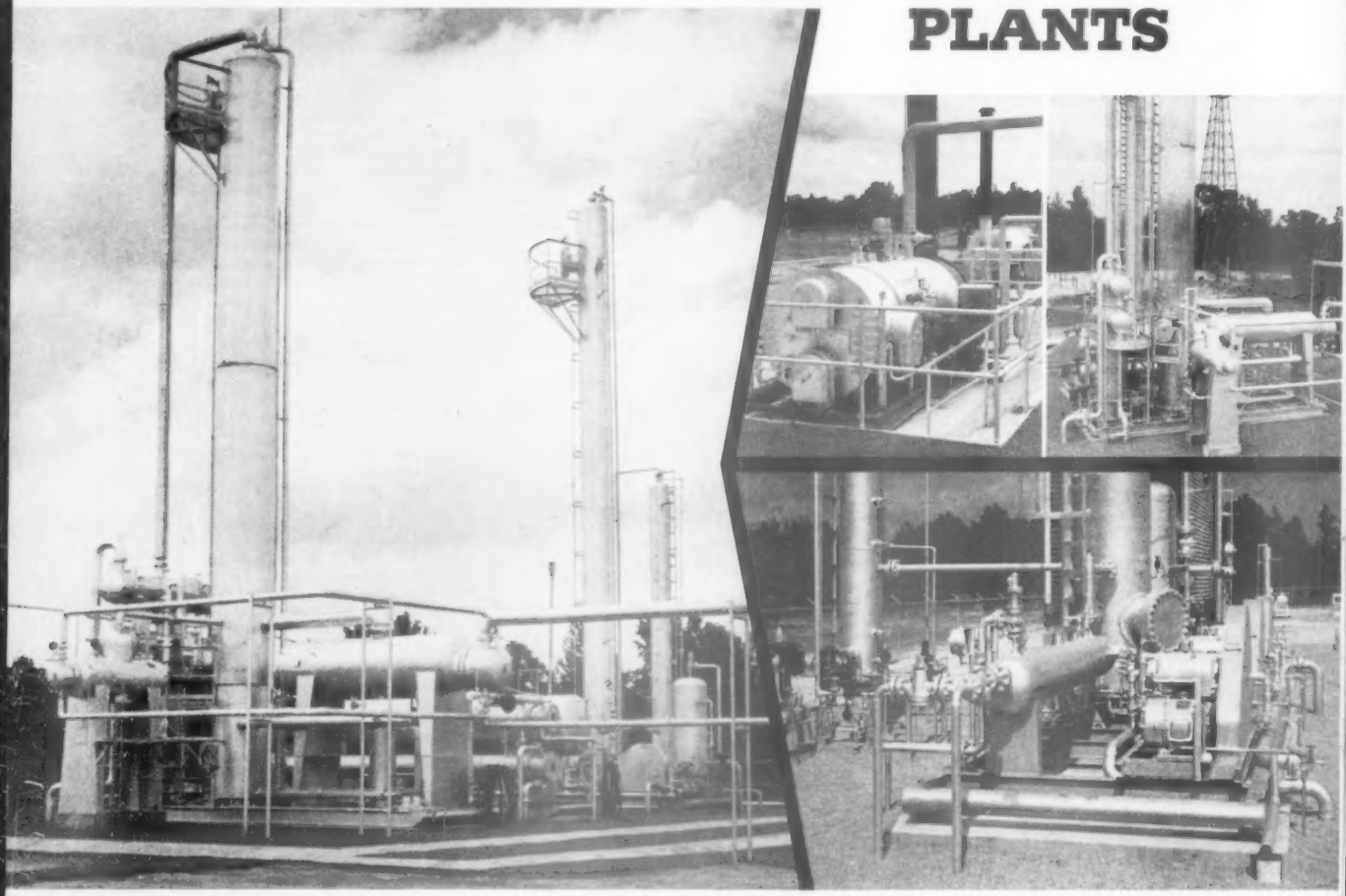

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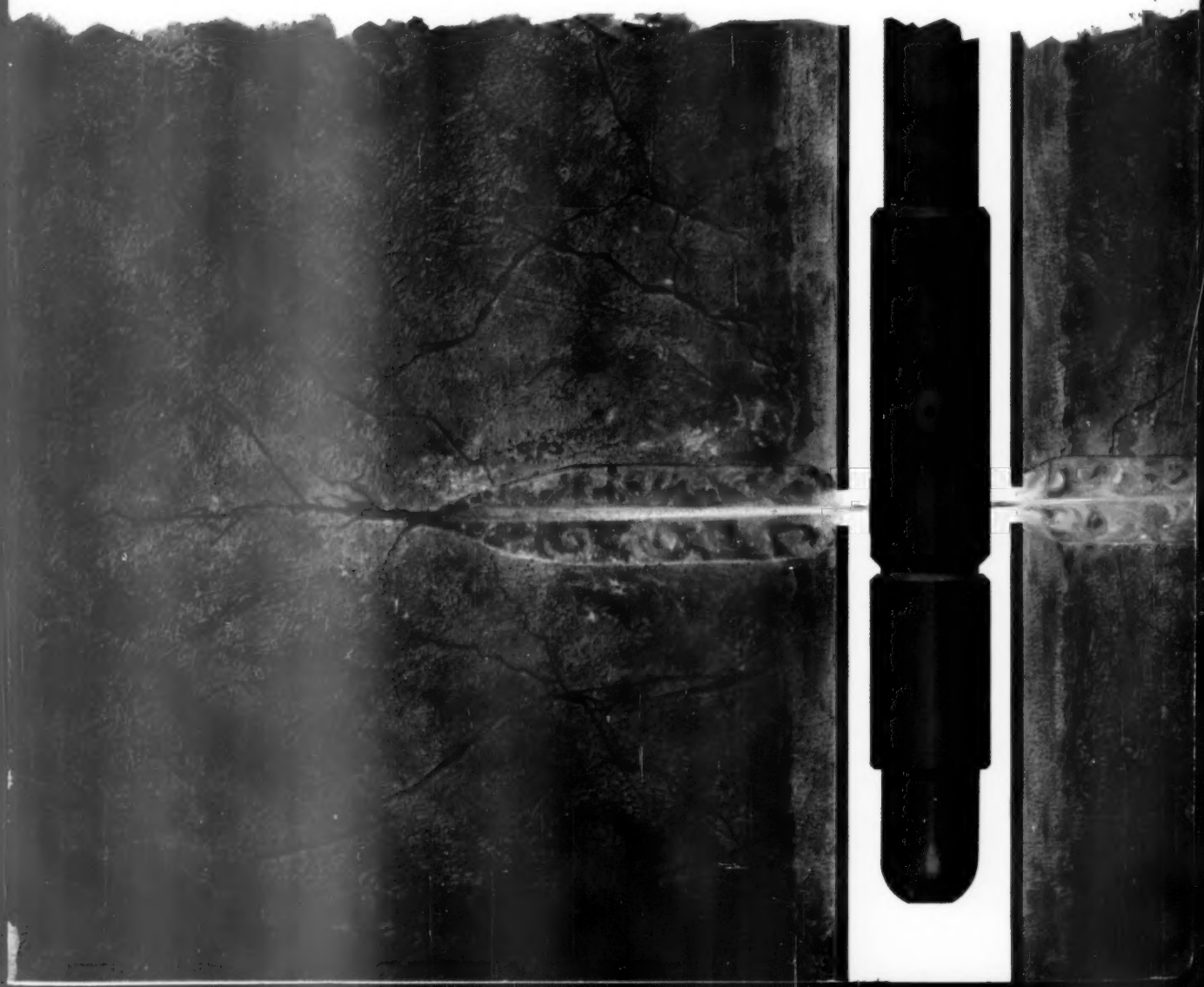

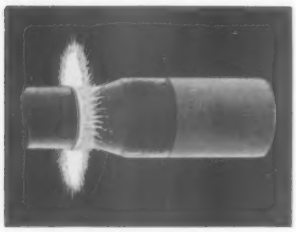

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